XXXI. *On the* MEGATHERIUM (*Megatherium Americanum,* BLUMENBACH).
By Professor OWEN, *F.R.S. &c.*
Part I.—*Preliminary Observations on the Exogenous Processes of Vertebræ.*

BEFORE entering upon the description of the skeleton of the Megatherium, it is requisite to premise some remarks on the vertebræ of the Mammalia in general. Hitherto these parts have been described by means of the terms supplied by Human Anatomy. But the skeleton of Man is one which deviates most from the common archetype: some parts are developed in excess; other parts, which are present as a general rule in the Mammalian series, are either rudimental or absent. The latter is more particularly the case with those processes of the vertebræ which are developed in relation to the attachment and force of the muscles; and which, being connected with particular modes and media of motion, become eminently significative of the habits and affinities of the species. The consideration and comparison of these processes, therefore, most of which have received no names in Human Anatomy, are essential to a right determination of the habits and affinities of the Megatherium; and in order to make intelligible the terms in which the vertebral peculiarities of that great extinct animal will be described, I propose first to illustrate them by giving a comparative survey of the principal modifications of the exogenous processes in the vertebrate series.

The 'exogenous' processes of a vertebra are those which grow out of the previously ossified parts, and are so classified and named in contradistinction from the 'autogenous' parts or elements of a vertebra which are developed from their own proper centres of ossification*.

In the sixth cervical vertebra, for example, of the human fœtus, the part which SOEMMERRING, the most exact and classical author on Anthropotomy, calls "radix prior seu antica processus transversi vertebræ†," is developed from a separate centre and for some time continues to be a distinct bar of bone; whilst the part called "radix postica processus transversi vertebræ‡," grows out of the base of the "radix arcus posterioris§," as SOEMMERRING denominates the autogenous part which I have called 'neurapophysis:' and from this element, or from the arch formed by its coalesence with its fellow, when it constitutes the "arcus posterior vertebræ" of SOEMMERRING, other processes grow out; as, for example, the "processus obliqui seu

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* On the *Plesiosaurus macrocephalus,* Geological Transactions, vol. v. 2nd series, p. 518, 1838.
† De Corporis Humani Fabricâ, 8vo. 1794, tom. i. pp. 239, 241.   ‡ Ib.   § Ib. *p.* 236.

articulares superiores et inferiores." These different processes offer many modifica-
tions of size and shape, and a certain change of position and direction, when traced
through the vertebrate series; in the course of which comparison the anatomist meets
with other exogenous processes, traceable with equal certainty from species to species
and determinable under all their various modifications: whence it becomes necessary
for the purpose of brief and clear description to indicate each of such processes by a
single definite name, capable of being formed into an adjective to express the pro-
perties or appendages of such processes*.

The convenience of such terms will be admitted by the Human Anatomist who
considers that the processes in question have, as yet, received no distinct substantive
names in Anthropotomy; and who knows, from Osteogeny, how vaguely some of the
descriptive terms, as 'transverse process,' for example, are applied to parts obviously
very different in their nature and constitution. The 'transverse process' of a dorsal
vertebra is a simple exogenous growth from the neurapophysis, commonly affording
an articular surface for a rib; the 'transverse process' of a sacral vertebra† is an
autogenous part, which continues distinct long after birth; the 'transverse process'
of a cervical vertebra is partly exogenous, partly autogenous, consisting in fact of
two distinct processes and a rudimental rib, but distinguished in Anthropotomy from
other transverse processes only by 'being perforated.'

But if such common phrase of 'transverse process,' with a note of distinction, as
that "it is perforated in the cervical vertebræ," be sufficient for the exigencies and
applications of Human Anatomy, it becomes quite inadequate and often totally inap-
plicable to the answerable parts in the lower animals: in the Crocodile, for example,
the cervical rib is much more developed and maintains constantly a free articulation
by a 'head' with a well-developed inferior *transverse* process ('radix antica,' SOEMM.),
and by a 'tubercle' with an equally distinct superior *transverse* process ('radix pos-
tica,' SOEMM.). In the Wombat (Plate XLIV. fig. 12), the Hare, the Pig, and most other
quadrupeds, the *transverse* process of the lumbar vertebræ consists of an exogenous
base and an autogenous apex, this apex being, as THEILE and MULLER‡ have
shown, a rudimental rib like the autogenous part of the transverse process in the
neck.

In entering upon the descriptions of the extinct species of the Reptilian class§, the
most varied, extraordinary and heteroclite, as CUVIER justly remarks, of any of the

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* This I have done for some years past in my Lectures at the Royal College of Surgeons, in the 'Catalogue
of the Human and Comparative Osteology in the Museum of the College,' and in some of my published me-
moirs: as *e.g.* On the *Plesiosaurus macrocephalus*, Geological Transactions, 4to, 1838. On the Anatomy
of the Male Aurochs (*Bison europæus*), Proceedings of the Zoological Society, November, 1848, p. 131.

† "Laterales partes, quæ processus transversos coalitos repræsentant," SOEMM. *op. cit.* t. i. p. 271.

‡ Archiv für Anatomie und Physiologie, Jahrg. 1839. Vergleichende Anatomie der Myxinoiden, in 'Berlin
Abhandlungen,' 1836, p. 304.

§ Reports of the British Association, 1839.

lost forms of animal life, I found that a very large proportion of their fossil remains consisted of vertebræ or parts of vertebræ, and that a definite idea of these complex bones, with a substantive nomenclature for their parts, was indispensable in order to give a clear and intelligible description of them. In a memoir on the *Plesiosaurus macrocephalus* read before the Geological Society, April 1838, I therefore defined the parts of the typical vertebra, distinguished the autogenous elements from the exogenous parts, and proposed the nomenclature which I have since used and further illustrated in subsequent works. Referring more particularly to my ' Lectures on the Comparative Anatomy of the Vertebrate Animals*,' and my work ' On the Archetype of the Vertebrate Skeleton†,' for the fuller exposition of the views entertained by anatomists on the nature of the vertebra, it is sufficient for the present purpose to remark, that the term ' parapophysis' was proposed for the ' inferior transverse process,' or ' anterior root of the perforated transverse process of the cervical vertebræ'; the term ' diapophysis' for the ' superior transverse process,' or ' posterior root of the perforated transverse process'; and the term ' pleurapophysis' for that element, which, essentially the same in different regions of the spine, is short, styliform, and speedily anchylosed in the neck of Man, is remarkable for its length and freedom of motion in the back, and is as remarkable for its breadth, thickness, and wedged fixedness in the sacrum; which is hatchet-shaped and free in the neck of the Crocodile and Plesiosaurus; and is as broad and flat, in the first dorsal segment of a Whale, as the ordinary mammalian scapula or any of the ' flat bones' in Anthropotomy.

The necessity for a definite technical term for this vertebral element was the greater because the name ' costa' or ' rib' has not only been withheld in Human Anatomy from the element in question, under every modification save that in which it retains its individuality and mobility with a certain length and slenderness; but it has been extended to another and quite distinct element, viz. the ' hæmapophysis,' which from being commonly cartilaginous in the thorax of Man, has obtained the name of ' cartilage of the rib,' or ' pars cartilaginea costæ.' As this part however is most commonly a distinct ossified part in the air-breathing Vertebrata, it has been called in Comparative Anatomy the ' sternal rib,' in contradistinction to the ' vertebral rib' or ' pars ossea costæ' of Anthropotomy. Both, however, are distinct elements of the ' vertebra' in its true or wider anatomical sense; each may exist independently of the other, and the hæmapophysis is often present in other regions besides the sternal or thoracic one.

The subject, however, of the present communication being the ' exogenous parts of the vertebræ,' I shall return to it by remarking, that, in Human Anatomy, other processes have been recognized besides the ' spine,' the ' zygapophysis' (oblique or articular process), the ' diapophysis' (transverse process and ' radix postica' in the neck) and the ' parapophysis' (part of the ' radix antica' in the neck). MONRO, for

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* 8vo. LONGMANS, 1846.   † 8vo. VAN VOORST, 1848.

example, the first exact describer of Human Osteology, when treating of the lumbar vertebræ, observes,—" 5. Betwixt the roots of the superior oblique and transverse processes a small rising may be observed, where some of the 'musculi erectores trunci corporis' are fixed*." And SOEMMERRING bears testimony to the accuracy of MONRO's observation of this 'small rising' as a constant part, by calling it " processus accessorius processui transverso et articulari superiori interpositus†." There are, in fact, two such accessory processes, as SOEMMERRING, indeed, seems to indicate. One of these 'small risings' or 'accessory processes,' although it seems so insignificant, and is so small, as to be commonly passed over without notice in our modern anthropotomical compilations‡, is not only so constant as to merit unfailing notice in the human subject; but, in extending our comparisons from Man to the lower mammalia, we find it speedily, in the Quadrumanous Order, for example, gaining a development which makes it, in the dorsal and lumbar regions, more conspicuous than the articular processes themselves: whence CUVIER, observing its relation to the anterior of these processes, calls it " une seconde apophyse articulaire§;" and M. DE BLAINVILLE, struck rather with the shape of the process, calls it " apophyse styloïde‖;" whilst M. STRAUS-DURCKHEIM, regarding it as a sort of accessory transverse process, prefers to call it " apophyse plagienne¶:" I have termed it the ' anapophysis**.' The second tubercle is usually a somewhat larger process, situated between the diapophysis and the upper or anterior zygapophysis; it is equally constant in certain vertebræ in Man, and attains in some mammals, the Armadillos for instance, as great a length as the spinous process itself. The part in Man to which I allude is that which the accurate BOURGERY has depicted in his beautiful plates, and indicated as the ' face rugueuse de l'apophyse articulaire supérieure††.' STRAUS-DURCKHEIM mistakes it for the superior articular process itself, in the feline quadrupeds, calls it ' apophyse antoblique,' and denies the existence of anterior oblique processes in the third to the ninth dorsal vertebra inclusive; which do, in fact, possess the articulating surfaces so called, but want the accessory process which becomes so markedly developed in the posterior dorsal and lumbar vertebræ. For this accessory process I have proposed the name of ' metapophysis‡‡,' and have noticed some of its modifica-

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* The Anatomy of the Humane Bones, 12mo, 1726, p. 202. In later editions he calls it a ' small protuberance.'

† Op. cit. tom. i. p. 268. He speaks of two such processes, but whether he meant the pair of metapophyses, or both met- and an-apophysis, is uncertain.

‡ I may instance BELL's Anatomy, vol. i. ' On the Bones,' &c., ed. 1826, p. 20, and the Anatomist's Vade Mecum, by ERASMUS WILSON, 12mo, 1842.

§ Leçons d'Anat. Comp., ed. 1835, t. i. p. 197.   ‖ Ostéographie, passim.

¶ From πλάγιος, transversus. Anatomie du Chat, t. i. p. 95.

** From ἀνὰ retro, ἀπόφυσις processus, because it generally projects more or less backwards.

†† Traité Complet de l'Anatomie de l'Homme, fol. t. i. pl. 9. figs. 2 and 4 k. This appears to be indicated, in the 5th edition of QUAIN's ' Anatomy,' as a tubercle projecting from the superior articulating process.

‡‡ From μετὰ inter, ἀπόφυσις processus, because it is usually between the transverse process (diapophysis) and the anterior oblique process (prozygapophysis).

tions in my 'Anatomy of the Male Aurochs,' in which, as in most other Ruminants, the anapophysis is not present *. The process which is developed, sometimes singly, sometimes in pairs, from the under part of the centrum in some mammals and in most birds and reptiles, I have called '*hypapophysis*†.'

I propose in the first place to trace the homologies and to indicate the chief modifications of the metapophyses and anapophyses in the mammalian class, and thereby to vindicate their title to distinct names, and demonstrate the utility, if not the necessity, of such signs for parts so constant in existence and so variable in character in a great proportion of that class. I may remark, also, that as I shall frequently have to allude to the anterior as distinct from the posterior zygapophyses, I shall call the former 'prozygapophysis,' and use the term 'zygapophysis' simply to signify the posterior pair.

* "With regard to the vertebræ of the trunk of the Aurochs, I may remark, that the only accessory process in addition to the ordinary zygapophyses and diapophyses is the 'metapophysis,' which appears as a stout tubercle above the diapophysis in the middle dorsals, and gradually advances and rises upon the anterior zygapophyses in the posterior dorsal and lumbar vertebræ. This process is developed to an equality of length with the spinous processes in the Armadillos. It is commonly associated with another accessory exogenous process, to which I have given the name 'anapophysis' in the Catalogue of the Osteological Series in the Royal College of Surgeons. This process, which in most of the *Rodentia* rises, at first, in common with the metapophysis, as a tubercle above the diapophysis, separates from the metapophysis as the vertebræ approach the pelvis, and in the lumbar series the anapophysis is seen projecting backwards from the base, or a little above the base of the diapophysis, its office being usually that of underlapping the anterior zygapophysis of the succeeding vertebræ and strengthening the articulation, whence CUVIER has alluded to it as an accessory articular process; but its relation to the zygapophysial joint is an occasional and not a constant character. The tenth dorsal vertebra of the Saw-toothed Seal, *Leptonyx serridens*, affords a good example of well-developed metapophyses; they are also large in most of the trunk-vertebræ of the Tapir. The anapophyses are well-developed in the anterior lumbar vertebræ of the Hare and Rabbit."—Proceedings of the Zoological Society of London, November 1848.

In a volume of Swedish Transactions, for 1848, Prof. RETZIUS has a paper, illustrated by woodcuts, on the modifications of some of these processes in the Class *Mammalia*. I have been recently favoured with a copy of the memoir by the learned author, bearing date 'Stockholm, 1850,' on the title-page, and received since the greater part of this paper was written and all the materials for it collected, which has been a work of some years past; but I regret that my ignorance of the Swedish language has prevented my profiting by the remarks of the estimable anatomist. In the cuts the metapophyses are called 'processus mammillares,' the anapophyses 'processus accessorii.'

[In a German translation of this memoir, kindly transmitted to me by Prof. RETZIUS since the present paper was in type, the following passage is added to the original :—

" (Zusatz des Verfassen; aus brieflicher Mittheilung desselben au den Uebersetzer vom 5 August 1850.— Nachdem diese Abhandlung bereits gedruckt war, hat der Verf. erfahren, dass Prof. RICHARD OWEN in London schon i. J. 1848 (Proceedings of the Zoological Society) den *Pr. mammillares* sowohl als den *Pr. accessorii*, eigene, einfache Benennungen gegeben hat. Er nennt nämlich die ersteren oder Pr. mammillares ' Metapophyses' und die letzteren oder die Pr. accessorii ' Anapophyses,' von μετὰ *inter*, und ἀνὰ *retro*, die ersten als zwischen den Diapophyses und Zygapophyses *Owen* liegend; die letzteren als mehrentheils nach hinter gerichtet.") p. 449.]—R. O. October 27th, 1851.

† From ὑπὸ *sub*, ἀπόφυσις *processus*.

Order BIMANA. Genus *Homo*.
Var. *Caucasica*, seu *Indo-Europœa*.

In the skeleton of a Frenchman, from which the figures 1 and 2 of Plate XLIV. are taken, the metapophysis first appears as a prominence (*m*) from the fore-part of the diapophysis (*d*) of the tenth dorsal vertebra : it becomes a distinct and well-marked process (*m*) from the upper and fore-part of the diapophysis of the eleventh dorsal vertebra, where the rudiment of the anapophysis (*a*) may be discerned. In the twelfth the metapophysis has increased in size and advanced nearer to the prozygapophysis (*z*, 12, fig. 2), and the anapophysis (*a*), though small, becomes distinct on this vertebra. Both processes are reduced in size in the first lumbar vertebra, in which the metapophyses (*m*) have advanced to the outer side of the prozygapophyses (*z*) ; while the anapophyses have descended to the back part of the base of the diapophysis. An anapophysis (*a*) becomes well-developed behind the base of the diapopophysis of the fourth lumbar : the metapophyses are reduced to tuberosities in the last four lumbar vertebræ.

In the skeleton of an Englishman, in the Museum of St. Bartholomew's Hospital, the metapophyses begin to be developed on the diapophyses of the tenth dorsal, are intermediate between the diapophyses and zygapophyses in the eleventh, are so placed in the twelfth as to overlap the posterior zygapophyses of the eleventh, and are large round tubercles upon the prozygapophyses of all the lumbars save the last.

In the skeleton of an Englishman with six lumbar vertebræ, in the Hunterian Museum, the metapophysis rises in common with the anapophysis, as a tubercle upon the diapophysis of the eleventh dorsal vertebra; the met- and an-apophyses become separated and of greater length on the twelfth dorsal, and continue equally distinct and well-developed on the first lumbar, which, from the persistent mobility of one of its pleurapophyses, might be equally regarded as a thirteenth dorsal. The metapophyses, however, subside as usual to mere tuberosities on the second lumbar, but the anapophysis continues to the fifth lumbar vertebra, in which it is most developed. It is obsolete on the last lumbar.

In the skeleton of the Irish giant, in the same museum, the metapophyses become distinct processes on the eleventh dorsal, and are repeated on the twelfth dorsal and first lumbar vertebræ : the anapophyses appear on the twelfth dorsal, and are repeated on the three first lumbar vertebræ*.

* The common subsidence of the accessory processes on the last lumbar vertebra seems to have attracted the notice of GALEN, who writes in his chapter ' De lumborum vertebris,'—" Et sane alia quædam declivis in ipsis apophysis est ab insigni exortu nervi constituta, hæc quæ interdum quidem inest omnibus, interdum vero in postremis aut exigua plane, aut prorsum nulla, sed superposita perpetuo ipsam habeat, quemadmodum et ultimæ dorsi duæ."—De Ossibus, Cap. x. Opera, fol. ed. by RENATUS CHARTERIUS, Lutetiæ Parisiorum, 1679, p. 18. The *processus declives* here described by GALEN in the last two dorsal and the upper lumbar vertebræ, would seem, from their defined direction, to be the ' anapophyses :' but the origin assigned to them—παρὰ τὴν ἔκφισιν τοῦ νεύρου—near the outlet for the nerve, does not exactly apply. Accordingly VESALIUS, commenting on this passage, writes,—" Ego hunc processum in humanis vertebris nunquam reperi." And he adds,—" In

Var. *Malayana.*—In the skeleton of a male Polynesian, the metapophyses are well developed and project midway between the diapophyses and prezygapophyses on the eleventh dorsal: they rise above the prezygapophyses on the twelfth, in which there is a rudimental anapophysis, as well as a small diapophysis. The anapophysis subsides to a ridge in the lumbar vertebræ, where the diapophysis suddenly increases in length and thickness.

Var. *Papuana.*—In the skeleton of an Australian, the metapophysial tubercle, which is slightly indicated in the tenth dorsal, becomes more distinct in the eleventh, and is well developed in the twelfth dorsal. In this vertebra the anapophysis is first distinctly recognizable. In the first lumbar the metapophyses have increased in size, but do not project so freely by reason of the extension of the articular surfaces of the prezygapophyses upon the inner sides of their base. The anapophyses continue distinct. Both metapophyses and anapophyses, though small, are distinct on the second as well as the third lumbar vertebræ: the metapophyses subside on the fourth lumbar, but the anapophyses are distinctly developed in it. In the last lumbar the anapophyses appear like a part of the upper border of the base of the diapophyses, pinched up and produced backwards.

In the following observations from the lower Mammalia, *d* signifies the dorsal vertebræ, and *l* the lumbar vertebræ, in the formulæ in which their numbers are given.

Order Quadrumana.

In the Chimpanzee (*Troglodytes niger*), with *d* 13, *l* 4, the metapophysis, commencing at the eleventh dorsal, is very distinct on the twelfth dorsal, where it projects forward from above the diapophysis: in the thirteenth dorsal the metapophyses are thicker and longer than they usually are in the last dorsal of Man. In all the lumbar vertebræ they project from the upper and outer part of the anterior zygapophyses, from which they are separated by a narrow groove. There is a feeble rudiment of an anapophysis from the back part of the long and depressed diapophysis: it is longer and more distinct at the back part of the diapophysis of the last lumbar.

In a young of the great Bornean Orang (*Pithecus Wurmbii*), with *d* 12, *l* 4, the metapophysis begins to project from the anterior angle of the diapophysis in the seventh dorsal, progressively increases in size, and is advanced in position close to the anterior zygapophysis in the last dorsal, which resembles that of Man in the distinct

simiarum igitur lumborum vertebris ad radicem transversi processus in inferiori ipsius sede, acutus conspicitur processus, rectà deorsum protensus, et sinus qui nervi nomine illic incisus est, externum latus quodammodo constituens, ac veluti intervallum cum descendente processu efformans, in quod ascendens inferioris vertebræ processus subintrat . . . . . Peculiari enim cuidam extruitur musculo, quem simiæ cum canibus communem obtinent, et quo homines inferiorem dorsi partem non æque ac illa animalia in circulum flectentes, non minus destituuntur quàm omni presentis processus signo."—De Humani Corporis Fabricâ, fol. 1555, p. 96. In the latter statement, however, VESALIUS is in error; as will be seen by whoever compares the human spine with that of the Ape or Dog, in reference to the existence of the *signa* or rudiments of the anapophyses.

development of its metapophyses; but differs in the relatively smaller size of its body and its shorter neural spine.

In a mature Sumatran Orang (*Pithecus Abelii*), with *d* 12, *l* 5, the metapophysis appears as a tubercle near the base of the prozygapophysis of the twelfth dorsal vertebra. It is equally distinct on the first lumbar, but subsides to a slight eminence on the succeeding vertebræ. The anapophysis is only distinguishable from the diapophysis upon the first lumbar vertebra; where, however, it well illustrates the homotypal relation of the diapophysis to the same processes in the antecedent dorsal and the succeeding lumbar vertebræ.

In the *Hylobates syndactyla*, with *d* 13, *l* 5, the last dorsal shows well the distinct diapophyses, metapophyses, anapophyses and zygapophyses, more especially the distinction between the prozygapophysis and the now superadded metapophysis. The diapophyses progressively increase in the first three lumbar vertebræ, whilst the anapophyses diminish and disappear on the third lumbar. The metapophysis recedes from the prozygapophysis in the last lumbar vertebra, and becomes quite distinct from it on the first sacral, in which, nevertheless, the articular surface has a nearly vertical position.

In the Silvery Gibbon (*Hylobates Leuciscus*), with *d* 13, *l* 5, both metapophysis and anapophysis become distinct on the twelfth dorsal, and diverge from each other with increase of size on the thirteenth. The anapophysis disappears in the lumbar vertebræ, but the metapophysis is retained.

In the Papas Monkey (*Cercopithecus ruber*), with *d* 12, *l* 7, the metapophyses and anapophyses are separate and distinct upon the eleventh dorsal vertebra, and also in the succeeding vertebræ to the penultimate lumbar, where the anapophysis, which is remarkable for its length in the preceding vertebræ, disappears.

In the Wrinkled Monkey (*Macacus rhesus*), the common rudiment of the meta- and an-apophysis, situated upon the diapophysis in all the dorsal vertebræ, progressively increases and elongates as the dorsal vertebræ recede from the neck, and divides into the two distinct processes upon the ninth dorsal. The metapophysial tubercle ascends upon the prozygapophysis, and is continued throughout the lumbar series; the anapophysis increasing, as in *Cercopithecus*, in the anterior lumbars so as to underlap the prozygapophysis of the succeeding vertebra, disappears in the last lumbar.

In the Entellus Monkey (*Semnopithecus Entellus*), with *d* 12, *l* 7, the metapophysis exists, as an elongated tubercle, outside the anterior zygapophysis from the eleventh dorsal to the last lumbar: the anapophysis is present from the tenth dorsal to the sixth lumbar, it is long and styliform in the intermediate vertebræ.

In the *Macacus niger*, with 13 *d* and 7 *l*, the metapophysis is developed pretty clearly on the back part of the diapophysis of the tenth dorsal, and an anapophysis projects from its lower edge; on the eleventh these parts become still more distinct; in the twelfth the metapophysis is situated upon the prozygapophysis, and the

short but strong diapophysis developes from its lower edge the anapophysis; on the thirteenth the diapophysis has disappeared, but both metapophysis and anapophysis remain, the anapophysis being developed as a long pointed process. In the lumbar vertebræ the diapophyses reappear, but both the metapophyses and anapophyses are present, although they gradually diminish in size and distinctness to the sixth, and the anapophysis disappears on the last lumbar vertebra.

In the Brown Monkey (*Macacus nemestrinus*), with d 12, l 7, metapophysial and anapophysial tubercles are developed on the second and succeeding dorsal vertebræ, increasing in distinctness and size to the tenth (Plate XLV. fig. 3, 10, m, a). In the eleventh they suddenly become separate processes, and the metapophysis (m) developes a facet for the accessory articular surface of the posterior zygapophysis in the tenth dorsal. This additional interlocking is continued to the antepenultimate lumbar vertebra, the joint being further strengthened by the underlapping of the long-pointed anapophysis: this 'processus acutus' of VESALIUS disappears on the last lumbar. The diapophysis is a rudimental ridge in the last dorsal (d 12), but becomes a distinct depressed sharp plate in the first lumbar and progressively increases in size, with an antroverted direction in the succeeding lumbar vertebræ.

In a Mandril (*Papio Mormon*), with d 12, l 6, an anapophysial tubercle is developed from the diapophysis of each dorsal vertebra, progressively increasing in length and distinctness to the lumbar vertebræ, in which it gradually diminishes, and is reduced in the last to a mere ridge on the upper part of the base of the diapophysis: a corresponding ridge may be recognized on the first sacral vertebra. The metapophysis is suddenly developed from the tenth dorsal, and presents an articular surface to a second articular facet on the outer side of the posterior zygapophysis.

In another Mandril the accessory joint between the zygapophysis and the parapophysis begins between the tenth and eleventh vertebræ.

In the *Papio porcarius* a rudimental metapophysis and anapophysis may be recognized in all the dorsal vertebræ after the second: they gradually increase in size to the ninth, and more suddenly in the tenth, where the metapophysis articulates with the accessory facet of the posterior zygapophysis of the ninth. The metapophysis, anapophysis and diapophysis are quite distinct processes in the last dorsal; in the lumbar vertebræ the pointed anapophyses progressively decrease, and they disappear in the last of this series.

In a Spider-Monkey (*Ateles paniscus*), with d 14, l 3, the metapophyses begin to curve inwards from the second dorsal, assume the form of a distinct plate in the tenth and eleventh, and separate themselves from the anapophyses in the thirteenth and fourteenth dorsal vertebræ: the latter processes are suppressed in the last lumbar.

In the Marimonda (*Ateles Beelzebuth*), with d 14, l 4, the tuberous rudiment of the accessory processes above the diapophysis of the middle dorsals becomes a ridge, which is produced forwards into an angular metapophysis in the eleventh dorsal. In the thirteenth it is produced to the same extent backwards into an anapophysis: in

the fourteenth these processes are distinct and well-developed, but the diapophysis has disappeared; it reappears, however, in the lumbar vertebræ, from the first and second of which, nevertheless, the anapophysis continues to be developed; but this subsides in the last.

In the Capuchin (*Cebus capucinus*), with *d* 13, *l* 6, in the fifth dorsal the tubercles representing the met- and an-apophyses project distinctly, the one from the fore-part, the other from the back part of the diapophysis: they progressively increase in size and distinctness, and in the thirteenth dorsal the metapophysis has risen upon the anterior zygapophysis. The anapophysis continues to be developed to the penultimate lumbar vertebra.

In the Marmoset (*Callithrix sciureus*), with *d* 13, *l* 7, the tubercle above the diapophysis divides into a met- and an-apophysis in the ninth dorsal; in the tenth these processes diverge, and in the eleventh become quite distinct; they continue to increase in length to the fifth lumbar; the anapophysis then diminishing, and being suppressed in the last lumbar.

In the Black-fronted Lemur (*Lemur nigrifrons*), with *d* 12, *l* 7, the metapophysis begins to be developed in the middle dorsal vertebræ, and in the tenth projects from above the diapophysis: this disappears in the eleventh dorsal, and the metapophysis is on the outside of the anterior zygapophysis. From this vertebra a well-marked anapophysis is developed, and is continued from all the succeeding vertebræ. The diapophysis reappears upon the first lumbar, and increases in length and breadth as these approach the sacrum.

In a Ring-tailed Lemur (*Lemur Catta*), with *d* 13 and *l* 7, and in a Ruffed Lemur (*Lemur Macauco*), with *d* 12, *l* 7, the division of the 'transverse process' into di-, met- and an-apophyses is well shown in the tenth dorsal, and in the succeeding vertebræ the three processes are distinct and remote.

In the Indri (*Lichanotus Indri*), with *d* 12, *l* 9, the diapophyses of the dorsals support a metapophysial tubercle, which grows as the diapophyses diminish, and seems to take their place in the eleventh and twelfth dorsals: in the twelfth the metapophysis rises from above the prozygapophysis and is continued backwards upon a well-developed anapophysis which commences at once in that vertebra, and continues to be developed though decreasing in length to the penultimate lumbar inclusive. The metapophyses, which are prominent in the anterior lumbar vertebræ, gradually subside as they approach the sacrum. The diapophysis has a low rough tubercle in the first lumbar vertebra, which is developed into a depressed plate, increasing in length and breadth as it approaches the sacrum.

In the Slow Lemur (*Stenops gracilis*), with *d* 14, *l* 9, a metapophysial tubercle is developed from above the diapophysis from the first to the twelfth dorsal vertebra: in the thirteenth it takes the place of the diapophysis, and in the fourteenth it extends forwards and presents an articular surface to a facet on the outer side of the post-zygapophysis of the thirteenth vertebra. The metapophysis has the same disposition

and connections throughout the lumbar series, where it is above and distinct from the diapophyses, which are serial repetitions of the base supporting the anchylosed ribs on the first lumbar vertebra.

Order CARNIVORA.

In the Lion (*Felis Leo*), with *d* 13, *l* 7, the common base of the met- and an-apophyses appears as a strong ridge above the diapophysis of the tenth dorsal; the ridge increases in the eleventh, divides into a large and strong metapophysis and anapophysis in the twelfth; both of these increase in size in the thirteenth dorsal. The metapophyses are continued throughout the lumbar region: the anapophyses diminish to short and thin styliform processes, underlapping the prozygapophyses of the first four lumbars, and becoming rudimental in the rest. The prozygapophyses are distinctly developed in all the dorsal vertebræ anterior to that in which the metapophyses are superadded to them.

In the Puma (*Felis concolor*), with the same vertebral formula, the common accessory tubercle indicates the anapophysis by its backward production from above the diapophysis of the ninth dorsal (Plate XLV. figs. 5 and 6, *a*): the anapophysis grows longer in the tenth (fig. 5, *a*); and in the eleventh the metapophysis (*m*) suddenly shoots upwards and forwards, the anapophysis (*a*) diverges from it backwards, underlapping the metapophysis of the next vertebra, and both processes far surpass the diapophysis (*d*) in size, which clearly, however, coexists with them. It disappears in the thirteenth vertebra, in which both ana- and met-apophyses have increased in length; and the only question that remains with regard to the ' transverse process ' (*d*) of the following vertebræ is, whether it includes the diapophysis at its base, or consists solely of the connate pleurapophysis. The eleventh vertebra permits of no doubt as to the distinctness of the diapophysis (*d*) from the two larger superadded processes (*m* and *a*), and, in fact, a rudiment of the diapophysis may be recognized above the costal pit in the last dorsal. Fig. 6 shows the prozygapophyses (*z*) existing, as in all the anterior dorsals, independently of the metapophyses[*]: fig. 7 shows them coexisting (*z*) with metapophysis (*m*), anapophysis (*a*), and diapophysis (*d*). The neural spine in this vertebra, which is the centre of motion of the spine, is low and nearly vertical; the longer spines of contiguous vertebræ converge to it.

In the *Hyæna crocuta*, with *d* 15, *l* 5, the anapophyses begin to be distinct, and to project backwards in the thirteenth dorsal, underlap the prozygapophyses in the first three lumbar, and subside on the penultimate lumbar vertebra.

In the Wolf (*Canis Lupus*) and Dog, with *d* 13, *l* 7, the metapophyses begin to be developed on the eighth dorsal, and are continued throughout the lumbar series: the anapophysis projects backwards in the eleventh dorsal, and subsides to a mere ridge in the penultimate lumbar. In the Fox they begin to be developed on the seventh

* ' *Apophyses antobliques*,' STRAUS-DURCKHEIM.

dorsal, and are reduced to mere tubercles on the third lumbar. In the Civet (*Viverra Civetta*) and the Genette (*Viverra Genetta*) the anapophyses begin to be developed on the tenth dorsal, and continue to the penultimate lumbar vertebra.

In the Otter (*Lutra vulgaris*), with *d* 14, *l* 5, the metapophyses begin to be developed on the twelfth dorsal vertebra, and are continued throughout the lumbar series; they are low and obtuse. The anapophyses commence at the eleventh vertebra, and are continued to the penultimate lumbar.

In the Sable (*Mustela zibellina*), with *d* 14, *l* 6, the anapophyses are present from the ninth dorsal to the penultimate lumbar inclusive.

The Kinkajou, *Cercoleptes caudivolvulus*, with the same number of true vertebræ as the Sable, has the same disposition of the anapophyses.

In the *Mydaus meliceps*, with *d* 14, *l* 6, anapophyses are present only on the two last dorsal and first lumbar vertebræ: whilst in the Badger (*Meles Taxus*), with *d* 15, *l* 5, they are present on the first three lumbar vertebræ.

In the labiated Bear (*Ursus labiatus*), with *d* 15, *l* 5, the met- and an-apophyses are distinct on the twelfth dorsal, diverge and increase on the succeeding dorsals, the metapophyses continuing throughout the lumbar series, the anapophyses, after underlapping the prozygapophyses of the first and second lumbar, rapidly subsiding.

In the Saw-toothed Seal (*Leptonyx serridens*), with *d* 15, *l* 5, the metapophyses commence as tubercles outside the prezygapophysis on the second dorsal, are distinct on the third dorsal, pass on the fore-part of the diapophysis in the fourth, and continue rudimental as far as the tenth dorsal, on which they are well and distinctly developed (Plate XLVI., fig. 8, *m*); they again pass upon the outside of the prozygapophysis in the eleventh and twelfth dorsals, and so continue throughout the lumbar, sacral, and anterior caudal vertebræ. The anapophyses are mere rudimental projections from the back part of the diapophysis (fig. 8, *a a*).

Order Rodentia.

In the skeleton of the common Squirrel (*Sciurus vulgaris*), with *d* 12, *l* 6, may well be discerned the progressive metamorphosis, in the last six dorsal vertebræ, of the common accessory tubercle upon the diapophysis into the metapophysis and anapophysis, which distinctly coexist with the diapophysis in the ninth dorsal: the diapophysis subsides to a feeble ridge in the three following dorsals, but reappears and rapidly increases in the lumbar series; in the last two of which the anapophyses are suppressed.

In the Malabar Squirrel (*Sciurus maximus*), with *d* 13, *l* 6, the ridge above the diapophysis of the seventh dorsal rapidly expands in the succeeding ones, divides in the tenth into metapophysis and anapophysis, which become more distinct in the eleventh, and are so continued throughout the lumbar series.

In the Marmot (*Arctomys Marmotta*), with *d* 12, *l* 7, the accessory tubercle appears upon the diapophysis of the ninth dorsal, and divides in the tenth, in which the di-

apophysis is suddenly shortened: the metapophysis and anapophysis are distinct in the eleventh dorsal, and so continue to the penultimate lumbar.

In the *Hydromys chrysogaster*, with *d* 14, *l* 7, the common tubercle divides on the twelfth dorsal, and the met- and an-apophyses are distinct on the five following vertebræ.

In the Rat (*Mus rattus*), with *d* 13, *l* 6, the common tubercle, which first appears on the sixth dorsal, divides into metapophysis and anapophysis in the ninth. The anapophyses become obsolete in the last two lumbar vertebræ.

In the Cape-Jerboa (*Helamys capensis*), with *d* 12, *l* 7, the diapophyses of the first dorsal vertebra are unusually long and strong: the anapophysis begins to be developed from the back part of the diapophysis of the eighth dorsal, and the metapophysis from the front part of that of the ninth; in the tenth dorsal (Plate XLVI., fig. 9) both metapophysis (*m*) and anapophysis (*a*) are distinct from the diapophysis (*d*). In the twelfth dorsal the metapophysis ascends upon the prozygapophysis, the anapophysis has increased in length, and the diapophysis is retained. Both ana- and met-apophyses are of considerable length in the lumbar region, except in the two last vertebræ.

The progressive development of the accessory tubercle, and its transformation into metapophysis and anapophysis, are well exemplified in the last five dorsal vertebræ of the Beaver (*Castor fiber*).

In the Porcupine (*Hystrix cristata*), with *d* 15, *l* 4, the accessory tubercle begins to be developed upon the fourth dorsal, and, progressively increasing, it divides in the eleventh into metapophysis and anapophysis. The distinction of these from the diapophysis which supports the last floating rib is well-marked in the last dorsal vertebra. In the lumbar vertebræ the anapophyses strengthen the joints by under-lapping the metapophyses, but both processes become rudimentary in the last lumbar vertebra.

In the Coypu (*Myopotamus Coypus*), with *d* 13, *l* 6, the common tubercle appears upon the sixth dorsal; progressively expands, and in the twelfth divides into met-apophysis and anapophysis: the latter subsides in the last lumbar vertebra, but the metapophysis is continued along the sacral and a great part of the caudal region, continuing long after the true zygapophyses have disappeared.

In the Paca (*Cœlogenys Paca*), with *d* 13, *l* 6, the common rudiment of the met- and an-apophyses extends above the diapophysis of the seventh dorsal as a broad ridge; in the eighth the ridge is bilobed, in the ninth the lobes diverge; in the tenth and eleventh they become distinct processes: the anapophysis disappears in the last lumbar, but the metapophysis is retained in all the lumbars.

In the Hare (*Lepus timidus*), with *d* 12, *l* 7, both metapophysis and anapophysis appear abruptly on the ninth dorsal: the metapophyses progressively increase to the second lumbar, and are continued, remarkably developed, throughout that region: the anapophysis becomes a low long ridge in the last dorsal, and continues, as such,

with a slight posterior projection to the antepenultimate lumbar; it is rudimental on the penultimate one, and disappears on the last lumbar. The last dorsal and the three first lumbars are remarkable for their long hypapophysis.

In the *Lagotis Cuvieri*, with *d* 12, *l* 7, the common potential base of the dia-, ana- and met-apophyses divides more equally than usual into the three processes; and perhaps no better example can be had of their real distinctness from one another and from the zygapophyses, than that which the ninth dorsal (Plate XLVI. fig. 10, 9, *a, m, d, z, z′*) affords; the neural arch seems studded with processes, the nature of which is perfectly comprehended by the comparisons which are given in the present Memoir. In the tenth dorsal the anapophysis (*a*) and metapophysis (*m*) increase in size, especially the latter, which is now closer to the prozygapophysis. The anapophyses are remarkable for their length and slenderness in the lumbar vertebræ (*ib.* 2 and 3, *a a*). The long and slender anapophyses are equally remarkable in the *Lagostomus*, to judge from the figure of the skeleton in the Linnæan Transactions for 1828, vol. xvi. pl. 9, but as those processes had not at the time been defined in the Rodentia no notice is taken of them in the text.

The Capybara (*Hydrochœrus capybara*), with *d* 14, *l* 6, gives one of the best illustrations of the distinction of the metapophyses (*Apophyses antobliques* of STRAUS-DURCKHEIM) from the true anterior oblique processes. The metapophysis may be distinguished as a tubercle above the diapophysis from the third to the eighth dorsal vertebræ inclusive: at the eighth and ninth it (Plate XLVII. fig. 11, 8 and 9, *m*) begins to project forwards; in the tenth (fig. 11, 10, *m,*) it is longer than the diapophysis (*d*) that supports it; in the eleventh the metapophysis (*ib.* 11, *m*) begins to shift its position and rises half-way between the diapophysis and the prozygapophysis (*z*); in the twelfth dorsal it rises behind the prozygapophysis; in the fourteenth dorsal it has got above that process and the articular surface begins to ascend upon the inner side of its base: the change of place and aspect of that surface is completed in the lumbar series. The anapophysis separates itself from the metapophysis in the eleventh dorsal (*ib.* 11, *a*), and progressively increases to the penultimate dorsal, beyond which it decreases, and it disappears on the fifth lumbar. The diapophysis is suppressed in the last four dorsal vertebræ.

Order INSECTIVORA.

In the Hedgehog (*Erinaceus europæus*) the metapophysis commences as a slight tuberosity above the diapophysis of the second dorsal, becomes a distinct process in the third, projects outwards and forwards freely above the diapophysis in the fourth and fifth dorsals, ascends to the outside of the base of the prozygapophysis in the sixth, and continues there, inclining a little more upwards, and with increased breadth in the remaining dorsals, and in the lumbar vertebræ: also along the caudal vertebræ as far as the tenth, where the zygapophyses disappear and the metapophyses alone are present. There are no anapophyses.

The vertebral characters of the Tenrees (*Centetes*) resemble in these respects those of the Hedgehogs.

In the Moles (*Talpidæ*) short anapophyses are developed from some of the anterior lumbar vertebræ.

In the Shrews (*Soricidæ*) they are somewhat better marked; the anapophyses are continued from the penultimate dorsal to the third lumbar vertebræ in the great Indian species (*Sorex myosurus*); whilst in the *Cladobates ferrugineus* they under-lap the metapophyses of the succeeding vertebra in the last dorsals and in all, save the last lumbar vertebræ. The diapophyses in both *Talpidæ* and *Soricidæ* resemble those in the *Erinaceidæ*.

Order MARSUPIALIA.

In the Thylacine (*Thylacinus Harrisii*), with *d* 13, *l* 6, the anapophysis appears first upon the ninth dorsal, as a pointed process projecting from the back of the diapophysis; it increases in size and ascends in position on the tenth; is large, obtuse, and underlaps the metapophysis of the succeeding vertebra in the last two dorsals; progressively diminishes in the lumbar vertebræ, and disappears on the fourth of that series. The metapophysis is developed abruptly on the tenth dorsal external to the prozygapophysis, increases in size in the following dorsals, diminishes in the lumbar vertebræ, but is present throughout the series as a strong obtuse process: it is continued, also, through a great part of the caudal series, in which the zygapophyses become obsolete at the eighth vertebra.

In the Ursine Dasyure (*Dasyurus ursinus*), with *d* 13, *l* 6, both anapophyses and metapophyses commence at the eleventh dorsal: the anapophyses increase to the second lumbar, diminish in the two following, and disappear in the fifth. They underlap the metapophyses of the first three lumbar vertebræ. The metapophyses are continued throughout the sacral and a great part of the caudal region, in which the zygapophyses cease to be developed at the eighth vertebra.

The diapophyses are not obliterated in the last dorsal vertebræ, which renders their serial homology distinctly traceable along the lumbar region.

In the Wombat (*Phascolomys vombatus*), with *d* 15, *l* 4, the metapophysis (*m*) rises suddenly from the outside of the prozygapophysis (*z*) of the twelfth dorsal (Plate XLVII. fig. 12, D 12); increases in length to the second lumbar (L 2), diminishes by degrees to the second sacral; and is rudimental in the following sacral and caudal vertebræ. A rudiment of the anapophysis (*a*) is first discernible on the eleventh dorsal: the process gradually increases to the last dorsal (*a* D 15), diminishes in the lumbar, and disappears in the last of that series. In the skeleton showing the above modifications, the sutures between the short straight pleurapophysis (*pl*) and diapophysis (*d*) of the first lumbar vertebra (L 1) still in a great degree remain; the anchylosis is only partial; and the proportion of the autogenous and exogenous elements

of the so-called ' transverse process' is plainly demonstrated. The diapophysis, more-
over, is not suppressed on the last dorsal vertebra as in some of the *Quadrumana,*
Carnivora and *Rodentia.* The serial homology of the transverse processes of the lumbar
vertebræ is here, therefore, manifested in the most unequivocal way; both metapo-
physes (*m*) and anapophyses (*a*) coexist with diapophyses (*d*) in the last four dorsal
and the first three lumbar vertebræ. So that, whether the metapophysis or the an-
apophysis be the part called ' tubercle' by some Anthropotomists, neither of them
is in the lumbar vertebræ, the process named ' transverse' in the thoracic vertebræ;
that process, to which I restrict the name ' diapophysis,' is continued distinctly into
the lumbar region, and is there lengthened out by a superadded ' pleurapophysis,'
which is ossified from a distinct centre in the Wombat, but is not so ossified in the
human skeleton, in which only a mere epiphysis, like that at the extremity of the
spinous process, is superadded to the end of the transverse process of the lumbar
vertebræ*.

In the skeleton of the Great Kangaroo (*Macropus major*), with *d* 13, *l* 6, both

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* The author of the article ' Skeleton' in the Cyclopædia of Anatomy and Physiology, Part XXXV.,
March 1839, cites, p. 628, the following passage from my work on the Archetype and Homologies of the Ver-
tebrate Skeleton :—" Each of the five succeeding segments is represented by the same elements coalesced, that
constitute the so-called dorsal vertebra; they are called lumbar vertebræ; they have no ossified pleurapophyses,"
with the following comment :—" Professor OWEN's ' pleurapophysis' is the rib or costal appendage of his
typical vertebra. While he states, therefore, that the lumbar vertebra has no pleurapophysis, he means that it
has no rib or costal piece. This oversight (which, with all respect, I believe it to be) has arisen from the
evident error of mistaking the lumbar transverse process as being the counterpart or homologue of the dorsal
transverse process, which, if such were the case, would leave the lumbar vertebra without a rib." The passage
so commented on is taken from a ' Section' of my work treating of the specialities of the Human Skeleton; in
the ' Section' treating on lumbar vertebræ in general, I state,—" The lumbar vertebræ, which in some mammals
show, in the fœtal state, distinct rudiments of pleurapophyses more minute than those in the neck, have them
soon anchylosed to the extremities of the diapophyses, which are thus elongated," p. 94. No one proposing
fairly to criticise my opinions on the transverse process of a lumbar vertebra in general, ought to have repre-
sented them by a quotation of a description of the lumbar vertebra of a particular species. But taking the
passage upon the human skeleton, as cited above, the conclusion of the Critic that I " leave the lumbar vertebra
without a rib," can only be sustained by the omission of a word in that passage. What I do state is, that, in
them, " they have no *ossified* pleurapophyses." Now in a previous part of the work quoted from, it is shown,
that a vertebral element may exist in three states, ' fibrous,' ' cartilaginous,' ' osseous,' and that its absence was
not to be assumed merely because it had not passed into the bony stage. I have never met with a human lumbar
vertebra showing the transverse process lengthened out by a distinct autogenous ossification, meriting, like
that of the Wombat, Plate XLVII. fig. 12, L 1, to be regarded as a pleurapophysis : the whole is an exogenous
outgrowing diapophysis, with a minute epiphysis, which begins to be ossified about the age of sixteen, and is
comparable in my opinion with that at the extremity of the metapophysis and neural spine. As to the opinion
that the transverse process of the dorsal vertebra is homologous with the ' tubercle' of the lumbar vertebra,
whether by ' tubercle' is meant the metapophysis or the anapophysis, I need only refer to those skeletons of
mammalia, in which, as in the Wombat, Kangaroo and Dasyure, the true diapophysis is not suppressed on the
last dorsal vertebra, in order to ensure a conviction in every impartial observer that the exogenous part of the
transverse process of the lumbar vertebra is the serial homologue or tallying part with the diapophysis, or part
of the transverse process supporting the rib, of the dorsal vertebræ.

met- and an-apophyses commence, suddenly, on the twelfth dorsal, the former (*m*) as broad compressed plates from the anterior two-thirds of the side of the neural arch, the latter (*a*) as short processes from the hinder border of the same arch. The metapophyses (*m*) increase to the first lumbar, and after the second decrease to the sacral vertebræ : they again begin to increase in the caudals and attain great size in the third to the seventh of that series, in which latter vertebræ the zygapophyses have disappeared : but the metapophyses (see Plate LIII. fig. 62, a, c, *m m*) are continued to near the end of the tail. The anapophyses (*a*) increase to the second lumbar, and rapidly decrease after the third ; they are obsolete in the last lumbar.

The smaller *Macropus Parryi*, with the same vertebral formula, resembles the Great Kangaroo in regard to the accessory processes; except that the anapophyses are relatively smaller and begin in the eleventh dorsal (Plate XLVII. fig. 13, D 11, *a*) upon the diapophysis (*d*) ; passing in the twelfth to the back part of the neural arch ; they underlap the metapophyses (*m*) of the first four lumbar vertebræ and become mere rudiments in the two last (*ib.* L 5 and 6, *a*). In both species of Kangaroo the diapophyses (*d*) continue to be developed in the last dorsal vertebræ, rendering the homologies of those of the lumbar series unmistakeable.

In a *Perameles lagotis*, with *d* 13, *l* 6, the metapophysis begins at the ninth dorsal vertebra, rapidly increases to the first lumbar, and continues large, though slightly decreasing in the last two lumbars : they are continued along the sacrum and a great part of the caudal vertebræ. There are no anapophyses in this species.

Order MONOTREMATA.

The metapophyses are double, one behind the other, in the form of low tubercles, on each side of the neural arch of the third, fourth, and fifth dorsal vertebræ of the *Ornithorhynchus paradoxus*; they become single on the sixth dorsal, and gradually increase in size to the twelfth : beyond this vertebra they increase in antero-posterior extent chiefly, and thus attain their maximum of size in the last dorsal and the two lumbar vertebræ; they are continued throughout the sacral and to near the end of the caudal region. A rudiment of the anapophysis is discernible on the fourteenth, the fifteenth and sixteenth dorsal vertebræ, projecting backwards over the hole for the nerve at the side of the neural arch.

Order UNGULATA.

Suborder *Artiodactyla.*

Tribe *Ruminantia.*

In the Musk-Deer (*Moschus moschiferus*), with *d* 14, *l* 5 (Plate XLVIII. fig. 14), a distinct metapophysis (*m*) begins to be developed above the diapophysis of the second dorsal, is midway between this and the prozygapophysis in the tenth dorsal, rises upon the outside of the prozygapophysis on the eleventh, attains its greatest length

in the twelfth, and becomes thicker and more obtuse in the remaining dorsals and in the lumbar vertebræ. There are no anapophyses.

In the skeleton on which these observations were made, there is a peculiarity that well illustrates the serial homology of the diapophyses of the dorsal and lumbar regions. The tubercle disappears in the penultimate pair of ribs, and the diapophysis is reduced in the thirteenth dorsal vertebra to a short rough tuberosity (d'): but in the last pair of ribs the tubercle with its articular surface reappears, and the diapophysis (d) resumes its normal size and articulation with the rib, which inclines forwards at its commencement. In the first lumbar vertebra the diapophysis (d) suddenly increases in length and breadth, which increase is doubtless due to the ossified and coalesced rudiment of a rib (pl).

In the Meminna (*Moschus meminna*), with d 13, l 7, the metapophysial tubercle appears above the diapophysis of the anterior dorsals, projects as a distinct process midway between the diapophyses and prozygapophyses of the seventh to the tenth dorsals inclusive; gets upon the prozygapophysis of the succeeding dorsals and anterior lumbars, and subsides in the penultimate lumbar vertebra. The tubercle has disappeared on the tenth rib, and does not reappear in those that follow: but the diapophysis continues on the last four dorsal vertebræ, increasing in length upon the last two, and plainly showing the nature of the longer diapophyses in the lumbar region.

In the Elk (*Alces Americana*), with d 13, l 6, the metapophysial ridge becomes distinctly developed upon the diapophysis of the eighth dorsal, is a tubercle on the ninth, forms a process exceeding in length the diapophysis in the tenth and eleventh dorsals, and subsides to a tuberosity again in the twelfth and succeeding vertebræ, where its position has changed from the diapophysis to the zygapophysis. There is a slight trace of an anapophysis in the last lumbar vertebra.

In the Equine Antilope (*Antilope equina*), with d 13, l 6, the metapophysis is developed from the fore-part of the diapophysis of the second to the ninth dorsals inclusive, where it begins to be transferred to the outer side of the prozygapophyses, from which part it projects in the last four dorsals, and in all the lumbar vertebræ. There is a short anapophysis in the last two dorsals, but not in any of the lumbar vertebræ.

In the Gnu (*Catoblepas Gnu*), with d 14, l 6, there are no anapophyses; the metapophyses resemble those in the Equine Antilope.

In the Common Ox (*Bos Taurus*), with d 13, l 6, the metapophysis, beginning as a rudimentary tubercle at the anterior dorsals, increases in size in the tenth, eleventh and twelfth dorsals, in which it is transferred from the diapophysis to the prozygapophysis.

In the Aurochs (*Bison Europœus*), with d 14, l 5, the metapophysis is most distinct on the ninth, tenth and eleventh dorsals, in which it ascends to the prozygapophysis.

In the Giraffe (*Camelopardalis Giraffa*), with d 14, l 5, the metapophyses com-

mence as distinct and well-marked tuberosities above the diapophyses of the second dorsal; subside at the eighth, and are rudimental to the thirteenth; they recommence as distinct processes at the fourteenth dorsal, where they project forwards on the outer side of, but quite distinct from, the prozygapophyses; ascend upon those processes in the first lumbar, and so continue throughout the lumbar series. There are no anapophyses.

In the Camel (*Camelus Bactrianus*), with d 12, l 7, the metapophysial tubercle is developed from the diapophysis in the eleven anterior vertebræ, and passes upon the prozygapophysis in the twelfth, continuing in that position throughout the lumbar series. There are no anapophyses.

In the Vicugna (*Auchenia Vicugna*) the metapophysis is between the diapophysis and prozygapophysis, from the fourth to the tenth dorsal, and passes upon the prozygapophysis at the eleventh dorsal. There are no anapophyses.

Tribe *Non-Ruminantia*.

In an Indian Wild Boar (*Sus scrofa*), with d 13, l 6, the metapophysis commences as a tuberosity upon the diapophysis of the middle dorsal vertebræ, projects forwards midway between the dia- and prozyg-apophysis in the tenth, passes upon the prozygapophysis of the eleventh dorsal, and is continued in that position throughout the lumbar series. There are no anapophyses.

In the Peccari (*Dicotyles labiatus*), with d 14, l 6, the metapophysis begins to be developed at the third dorsal, and increases in length to the eleventh, beyond which it is transferred from the dia- to the prozyg-apophysis.

In the Hippopotamus (*Hippopotamus amphibius*), with d 15, l 4, a metapophysial ridge is developed above the diapophysis of the eighth dorsal, changes its position and shape in the succeeding vertebræ, and in the eleventh has passed, as a tuberosity, upon the prozygapophysis. It retains these characters throughout the rest of the dorsal and the lumbar series. There are no anapophyses.

Suborder *Perissodactyla*.

In the Horse (*Equus caballus*), with d 19, l 5, the metapophysis, commencing as a tuberosity above the diapophysis, passes gradually from that part to the outer side of the prozygapophysis, which it finally attains in the seventeenth dorsal vertebra, and continues in the same place throughout the lumbar series. There are no anapophyses.

In the Sumatran Rhinoceros (*Rhinoceros Sumatranus*), with d 19, l 3, the metapophysis begins, as a tuberosity, above the diapophysis of the fourth dorsal, projects distinctly forward from the eighth, and continues so projecting, and slightly increasing in length, to the seventeenth; in the eighteenth it begins to approach the zygapophysis, and gets outside of it in the nineteenth; and so continues, reduced to

a tuberosity, in the lumbar vertebræ. There are no anapophyses. The back part of the diapophysis of the last lumbar presents a distinct articular process for a corresponding one on the fore-part of that of the first sacral vertebra.

In the Sumatran Tapir (*Tapirus Malayanus*), a very distinct metapophysis projects upwards and forwards from the fore-part of the transverse process of the third dorsal; it becomes a thicker and lower tuberosity above the diapophysis on the four succeeding vertebræ: then again becomes prominent, with a rounded anterior edge in the succeeding dorsals, projecting from the fore-part of the diapophysis in the four last dorsals, where that process is raised above and is distinct from the rib, and projects upwards and outwards. In the lumbar region the metapophysis is very distinct, and does not pass upon the prozygapophysis until the last lumbar*. There are no anapophyses.

Tribe *Proboscidia*.

In the Asiatic Elephant (*Elephas Asiaticus*), with *d* 19, *l* 4, the metapophyses present a character different from that in all other *Ungulata*; they are first recognizable as an obtuse point projecting forwards from the fore-part of the diapophysis of the sixteenth dorsal vertebra; in the seventeenth the metapophysis has assumed a sub-depressed quadrate shape, and projects obliquely outwards and forwards from the outside of the prozygapophysis: in the eighteenth dorsal it extends forwards, and overlaps an anapophysis developed from the back part of the diapophysis of the seventeenth dorsal, and these accessory joints continue between the succeeding vertebræ as far as the first and second lumbars. The anapophyses have disappeared in the third and fourth lumbars, in which the metapophyses are reduced to short thick tuberosities, still projecting, not from above, but quite external to, the prozygapophyses. The metapophyses are continued along the sacral and caudal vertebræ, and in a large proportion of the latter supersede the prozygapophyses.

Order SIRENIA.

In the Dugong (*Halicore indicus*) there is a feeble rudiment of a distinct metapophysis on the outer side of the prozygapophysis of the fifth dorsal; but the homotypes of the metapophyses are so little developed in the preceding vertebræ, that the change of aspect of the articular surface seems to be due exclusively to a gradual change of position in the anterior zygapophyses themselves.

Order CETACEA.

In the small Bottlenose Whale (*Delphinus Tursio*), the metapophysis (*m*) begins to project from the fore-part of the diapophysis (*d*) of the third dorsal, increases in length

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* STRAUS-DURCKHEIM's term 'anapophyse antoblique,' applied to these processes in the Cat, would be quite inappropriate and unintelligible if applied to their homologues in the Tapir.

in the fourth (Plate XLVIII., fig. 15, D 4), and is gradually transferred in the sixth (D 6) and seventh (D 7) dorsals to the outer side of the prozygapophyses (z) : in the following vertebræ it seems to take their place, and to occasion a reversing of the usual relative position of the zygapophysis; for whereas in the cervical and anterior dorsal vertebræ the anterior zygapophyses are overlapped, as in other mammals, by the posterior zygapophyses, in the succeeding dorsals, beginning with the seventh, the posterior zygapophyses seem to be overlapped and concealed by the anterior zygapophysis. But this is not the case; the appearance is due to the place of the prozygapophyses (z) being taken by the metapophyses (m). These latter processes, in fact, continue after the articular surface has ceased to be developed, and after the entire disappearance of the posterior zygapophyses, to project forwards from the thirteenth dorsal to the sixth lumbar vertebra inclusive; beyond which the neural arch is devoid of all exogenous processes, save the spine, until the middle caudal vertebræ, where rudiments of the metapophyses again reappear.

In the common Dolphin (*Delphinus Delphis*), Plate XLVIII. fig. 16, the metapophysis (m) begins abruptly, as a long well-marked process, from the fore-part of the diapophysis (d) of the fourth dorsal (D 4); progressively approximates and attains the outside of the prozygapophysis in the eighth dorsal (D 8), performs the function of an articular process as far as the sixth lumbar, clamping, as it were, the sides of the back part of the base of the spine of the antecedent vertebra, disappears in the next dozen lumbar vertebræ, and reappears in the caudal vertebræ at the fore-part of the base of the spine.

There are no anapophyses in the *Cetacea*. With respect to the metapophyses, CUVIER, in his description of the vertebræ of the Dolphin, confounds them, as STRAUS-DURCKHEIM has done in the Cat, with the true zygapophyses. He writes,—" The last cervical and the six first dorsals have their articular processes joined together by horizontal facets, of which the anterior looks upwards. At the sixth they begin to be oblique, at the seventh they are nearly vertical, the anterior looking inwards [*]." But in the figure which he refers to, of the fourth dorsal vertebra of the *Delphinus Delphis*, the accurate artist, M. LAURILLARD, represents the metapophyses as distinct from the prozygapophysis or anterior articular process, although less so than it is in nature; and it is incontestably the progressive development of this superadded process which gives rise to the change of position of the articular surface of the connate prozygapophysis: and the metapophysis continues to be developed, as the figures in the ' Ossemens Fossiles ' demonstrate, long after the articular process or any articular surface has ceased to exist[†].

[*] Ossemens Fossiles, Ed. 1823, tom. v. pt. i. p. 303, pl. xxiii. figs. 25—29.

[†] This fact is clearly recognized by Professor STANNIUS, in his ' Vergleichende Anatomie der Wirbelthiere,' 8vo., p. 345, where he describes the ' metapophyses' as ' processus accessorii.'

Order Bruta (*Edentata*, Cuv.).

The exogenous processes of the vertebræ present their greatest and most complex developments in this order, but by no means with that degree of uniformity which renders their modifications characteristic of some of the preceding Orders. The twc extremes in the degree of development are, in fact, presented by the much-diversified families of the present extraordinary group of mammals.

The spinous processes are almost obsolete in a great part of the unusually long dorso-lumbar region of the Two-toed Sloth (*Bradypus didactylus*), and the metapophyses would be hardly recognizable if their modifications had not been previously traced in other mammals. The first indication of them is seen in the penultimate dorsal vertebra, where they appear as angular productions from the upper and fore-part of the diapophyses: in the last dorsal they have advanced clear of the diapophysis to the outer side of the prozygapophysis, the articular surface of which begins to ascend upon them; and they continue, as low and long tuberosities, above the prozygapophyses, throughout the lumbar region. In the sacral vertebræ they are obsolete. No anapophyses are developed in this species of Sloth*.

* In assigning, with Cuvier, this formula to the dorsal region of the spine, I have been guided by characters which have appeared to me more demonstrative of the homology of the eighth and ninth vertebræ of the Ai, with the last two cervicals of other mammals, than the sometimes persistent freedom of their short pleurapophyses are of their homology with the first two dorsals. The penultimate cervical vertebra, for example, has a well-marked and constant character in most mammals in the greater antero-posterior extent of its anchylosed pleurapophysis; and I find this character repeated in the eighth vertebra, counting from the atlas, in the Three-toed Sloth. Subjoined are the chief particulars which are noticeable in the cervical region of the skeleton of the mature specimen of that species in the Museum of the Royal College of Surgeons.

The hind-part of the bodies of the second to the sixth cervical vertebræ inclusive, are produced backwards and underlap the fore-part of the body of the succeeding vertebræ. The transverse process of the atlas is imperforate' but the base of the neural arch is pierced by the vertebral artery anteriorly and by the cervical nerve posteriorly. The spines of the cervical vertebræ are moderately and more equally developed than in other mammals; that of the dentata being little larger than the rest. The pleurapophysial part of the transverse process of the eighth cervical is anchylosed, and is more extended antero-posteriorly than in the preceding cervicals, in which respects it resembles the sixth cervical vertebra in ordinary quadrupeds. The pleurapophysial part of the transverse process of the ninth cervical is free, and is more extended in the direction of its length, but is very short compared with the homologous part of the succeeding vertebra. The slender neck and head of this little rib joining the fore-part of its centrum occasions the perforated character of the ninth, as in the antecedent cervical vertebræ. In the fourth cervical, however, the vertebral artery perforates the right transverse process, but only grooves the left on its anterior part. The transverse processes of the second and third cervical vertebræ are both imperforate.

The homology of the vertebra succeeding the ninth with the first dorsal of the Unau and of other mammals, is demonstrated by the junction of its rib with the manubrium by the superadded hæmapophysial element, which is here, however, ossified and anchylosed with both its pleurapophysis and the manubrium. Nine pairs of ribs directly articulate to the sternum, which consists of eight bones; these are compressed and progressively increase in depth. The hinder ones are divided into a larger posterior and a smaller anterior part, between which are four articulated facets on each side for the bifurcated extremities of two of the ossified hæmapophyses†.

† Proceedings of the Zoological Society, 1849, p. 146.

In the Ai (*Bradypus tridactylus*), with d 16, l 3, both met- (*m*) and an- (*a*) apophyses, Plate XLIX. fig. 17, are present, and the former are more distinctly developed than in the Unau : they are, however, restricted, as in that species, to a very few vertebræ. The metapophysis (*m*) is first developed as a distinct, though small obtuse conical process from the fore-part of the diapophysis (*d*) of the penultimate dorsal vertebra (D 15) ; it increases in size and approaches the prozygapophysis (*z*) of the last dorsal (D 16); ascends upon the outside of that process, and becomes more obtuse in the first (L 1) and following lumbar vertebræ.

In the *Orycteropus capensis*, with d 13, l 8, an accessory tubercle is developed upon the diapophysis of the seven anterior dorsal vertebræ, which divides near the eighth into metapophysis and anapophysis. These progressively increase and diverge from one another in the succeeding dorsals, and in the first lumbar vertebra the metapophysis projects upwards, outwards and forwards upon the outside of the anterior zygapophysis ; whilst the anapophysis extends backwards from the back part of the diapophysis, which it equals in length. The anapophysis decreases in size in the following lumbar vertebræ and disappears in the last*; the metapophysis also decreases in size, but is continued throughout the lumbar series and along part of the sacral. The transverse processes of the three anterior sacrals join the ilia ; those of the three posterior ones coalesce to form a broad depressed plate, with the posterior angles produced, but not joining the ischia. A long and strong process is sent out from above the tuber ischii. Metapophyses are developed from the outside of the anterior zygapophyses, as far as these extend along the caudal series, viz. to the eighth vertebra ; beyond these the metapophyses are developed, independently of the zygapophyses, to near the termination of the tail.

In the Long-tailed Armadillo (*Dasypus longicaudus*, Pr. Max.), with d 11, l 5, the metapophyses commence, abruptly, as long slender obtuse processes, on the seventh dorsal (Plate XLIX. fig. 18, D 7, *m*) rising midway between the diapophyses (*d*) and prozygapophyses (*z*), and projecting obliquely upwards and forwards : they pass upon the outside of the base of the prozygapophyses of the eighth dorsal (D 8, *m*), develope an articular surface from the inner side of their base for an extension of the surface of the zygapophysis upon its outer side in the ninth and succeeding dorsals; in the eighth dorsal they also develope a second articular surface from the under part of their base for articulating with the anapophysis of the seventh dorsal. The metapophyses in the following vertebræ, retaining their two articular surfaces, progressively increase in length until they exceed the neural spines in this respect in the last three lumbar

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* I have ascertained that the vertebral column of the so-called ' Ant-eater' exhibited by Dr. MELVILLE at the meeting of the Zoological Society, on December 12, 1848, in order to demonstrate " that the Edentata had no posterior or backwardly projecting processes from the diapophyses," is not of a true Ant-eater, but of an *Orycteropus*, in which, although the development of the anapophyses is much less than in the species of *Myrmecophaga*, they are nevertheless sufficiently recognizable. In no order of Mammals, as I shall presently show, are the ' anapophyses' or ' backwardly projecting processes' more extraordinarily developed than in the *Edentata*.

vertebræ. The anapophysis (*a*) commences on the seventh dorsal, projecting back-
wards behind the base of the diapophysis, and presenting on its upper side an arti-
cular surface for that beneath the base of the succeeding metapophysis. The anapo-
physis increases in length, but more so in vertical thickness in the succeeding ver-
tebræ. The diapophysis (*d*) subsides to a mere ridge in the last dorsal and disap-
pears in the lumbar vertebræ, where the transverse processes are formed by parapo-
physes. In the penultimate dorsal vertebra the anapophysis is notched posteriorly,
and developes a small surface from below its inferior division for articulating with
the head of the last rib. The succeeding anapophysis developes a similar surface for
articulating with a short and thick exogenous process or ' parapophysis': and this
complex condition of the anapophysis is continued throughout the lumbar region, the
last vertebra having a longer and narrower anapophysis. Thus on each side of the
fore-part of each lumbar vertebra there is *one* articular surface on the prozygapophysis,
a *second* on the inner side of the base of the metapophysis, a *third* on the outer and
under side of the same base, and a *fourth* on the upper side of the base of the para-
pophysis ; and on each side of the back part of the same vertebræ there is *one* articular
surface on the under side, and a *second* on the outer side of the posterior zygapophysis,
a *third* surface on the upper, and a *fourth* on the under side of the anapophysis ;
making sixteen synovial joints, four on each side of both fore and back parts of the
vertebræ, which joints may be called, beginning from above downwards, the 'zyg-
apophysial,' 'metapophysial,' 'anapophysial' and 'parapophysial' articulations respect-
ively* ; and the power of inflecting the substantive names for the several processes
and applying them adjectively to such modifications as I have described is not one of
the least advantages of such substantive names to the descriptive Anatomist. These
different articulations form double tenon-and-mortise joints on each side of the ver-
tebræ. But their comparison with these joints in artificial carpentry, affords but a
meagre idea of their true nature and complexity, whilst the supposition of their
homology with the similar tenon-and-mortise joints of the backbone of Serpents is,
as I shall presently demonstrate, unsupported by exact comparison.

In the *Dasypus tricinctus*, the true or moveable vertebræ present the following,
amongst other, characters :—

The spine of the third cervical has completely coalesced with that of the dentata,
which is thick and high, but more extended forwards than backwards. The spine of
the fourth cervical is applied to its back part. The neural arches of the succeeding
cervicals have no spines, but form thin transverse bars of bone above, which are
incomplete in the middle at the fifth and sixth cervicals, upon which the rest are
strongly bent backwards. Their bodies are extremely broad in proportion to their
length or antero-posterior diameter. The articular bed for the head and tubercle of
the first dorsal rib is contributed to in equal shares by the last cervical and first

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* The zygapophysial and metapophysial synovial sacs communicate and form a common joint in the posterior
dorsal and lumbar vertebræ.

dorsal vertebræ. Ten vertebræ show the impressions of the articulation of the head of the rib in addition to the first dorsal, and the neurapophyses of these eleven vertebræ are directly perforated by the spinal nerves, Plate XLIX., fig. 19, n, $n*$. The articulation for the last rib (pl) is as equally divided between the two contiguous vertebræ as is that of the first rib. The prominence (p) supporting the articular surface for the head of the rib answers to the parapophysis, just as the prominence for supporting the articulation for the tubercle of the rib, represents the diapophysis. The prominence in the first lumbar vertebra (p) which articulates with the under part of the anapophysis (a) of the last dorsal, repeats the prominence in that dorsal, which articulates with the head of the last rib; it is therefore a parapophysis. The diapophysis (d) projects, as in the dorsal vertebræ, from the upper and outer part of the base of the short and thick anapophysis (a), and this anapophysis presents, as in other Armadillos, two articular surfaces, one above, for the under part of the metapophysis (m), another below, for the upper part of the parapophysis (p). Thus the vertebræ are interlocked by tenon-and-mortise joints, as CUVIER has described, but it is by distinct parts of the vertebra from those which form the corresponding joints in the backbone of serpents.

The metapophysis (m, 7) begins in the seventh dorsal as a distinct process: the anapophysis is first developed in the sixth (a 6), and articulates with the under part of the first metapophysis; the subsequent metapophyses (m, m) present the usual progressive and great development, as also the two joints, one on the inner and the other on the under side of their base. Nothing can be more distinct than the anterior and posterior zygapophyses of the sixth dorsal vertebra: but equally distinct are the metapophyses which coexist with them in the seventh dorsal; to confound these two processes, or to describe the longer metapophyses in the subsequent vertebræ as developments of the anterior zygapophyses, is to confound two things manifestly distinct.

In the *Dasypus sexcinctus*, some modifications of the accessory processes are present, which render a notice of its vertebral characters desirable.

The vertebral formula is seven cervical, eleven dorsal, three lumbar, nine sacral, sixteen caudal. The second and third cervicals have coalesced together, and they develope a strong confluent neural spine. The last four cervicals are without those spines, and are equally devoid of zygapophyses. The diapophysis of the last cervical contributes to the articular cavity for the tubercle of the first dorsal rib, which is enormously expanded; and the anchylosed pleurapophysis of the seventh cervical projects backwards beneath the head of the first dorsal rib. The neurapophyses of the middle dorsal vertebræ are directly perforated for the spinal nerves. Anapo-

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* This is one of so vast a series of exceptions to the "Loi de conjugaison" of Prof. SERRES, as to deprive it of any claim to be considered as the law of formation of foramina, and to demonstrate the abuse of the term 'law,' in cases like that in which it has been made to express the idea that every foramen is formed by the approximation of two notches in distinct bones.

physes are developed from behind the diapophyses of the first three dorsals; they de-
crease in size in the succeeding dorsals, but again increase in the posterior dorsals
and in the lumbar vertebræ, where they present an articular surface to the metapo-
physis of the succeeding vertebræ. The metapophyses commence as ridges on the
upper surface of the diapophyses of the second and third dorsals; they form promi-
nent tubercles on the seventh and eighth dorsals, and rapidly elongate in the suc-
ceeding vertebræ, where they surpass in length and equal in thickness the neural
spines. They are much diminished in length in the first sacral vertebra. Each of
these elongated metapophyses presents a distinct articular surface to an accessory
posterior zygapophysis; and on its opposite side an articular surface to the subjacent
anapophyses of the preceding vertebra, producing two additional pairs of joints to the
normal ones formed by the anterior and posterior zygapophyses.

The parapophyses of the lumbar vertebra do not materially increase in length, but
chiefly in antero-posterior extent, overlapping each other, the back part of the ana-
pophysis of the last dorsal resting on the fore-part of the parapophysis of the first
lumbar vertebra, and the parapophyses of the last lumbar vertebræ similarly arti-
culating with a prominence of the iliac bone; an additional pair of articulations being
thus formed externally to those between the anapophyses and metapophyses.

The long sacrum has coalesced with both the iliac and ischial bones. The pubic
bones complete a wide arch by their confluence at their slender symphysis. The
ischiatic notches are converted into foramina, which are inferior in size to the fora-
mina obturatoria. The spines of most of the sacral vertebræ form by their conflu-
ence a continuous ridge. The strong tuberosity of the ischium is bifid. The zyg-
apophyses are developed and coarticulated in the first five caudal vertebræ. The an-
terior ones support short and thick metapophyses, and these are continued in the
succeeding caudal vertebræ, after the anterior zygapophyses have disappeared.

In the Pangolin (*Manis pentadactyla*), with *d* 13, *l* 4, the metapophyses commence
as tubercles on the first dorsal vertebra and rapidly increase in size. Anapophyses
are not developed. The metapophyses continue to be developed from the sacral
series. The transverse processes of the last sacral suddenly expand both in length
and breadth, and articulate with the tuberosities of the ischium. Well-developed
hæmal arches are articulated to the inferior interspaces of the caudal vertebra
as far the penultimate one. The anterior zygapophyses cease upon the fourteenth
vertebra of the tail, but the metapophyses are continued as far as the penultimate
caudal.

In the Tamandua (*Myrmecophaga Tamandua*), with *d* 17, *l* 2, all the cervical ver-
tebræ have spinous processes except the atlas; that of the dentata is produced for-
wards, not backwards, and those of the sixth and seventh cervicals are as long as the
spine of the first dorsal, which exceeds in length that of any of the other vertebræ.
The pleurapophysial part of the transverse process of the dentata is broad, and pro-
duced downwards and outwards: it increases in length and breadth in the four suc-

ceeding vertebræ, in the three last of which the diapophysial element of the process stands out distinctly and strongly. In the seventh cervical this element alone is developed, and the transverse process is accordingly said to be imperforate. A metapophysial tubercle is developed from the outer side of the prozygapophysis of the five last cervicals. The diapophyses of all the dorsals present an articular surface for the tubercle of the rib. The metapophysial tubercle is continued from the cervical to the dorsal region, appearing there upon the upper part of the diapophyses of the first dorsal; it continues increasing in size and length to the thirteenth dorsal, where it begins to shift its position, and in the remaining dorsals projects midway between the diapophysis and zygapophysis. In the fourteenth dorsal the metapophysis also increases suddenly in breadth, and developes an articular surface from its inner side to join an accessory posterior zygapophysis, as well as an articulation upon its fore and under part for the anapophysis of the preceding vertebra. In the fourteenth dorsal the anapophysis suddenly acquires increased length and breadth, with a distinct articular surface upon both its upper and under part, the upper one articulating with the metapophysis, the under one with the parapophysis of the succeeding vertebra. Thus there are not fewer than sixteen co-adapted articular surfaces, in addition to those for the head and tubercle of each rib and the articulations between the ends of the centrum of one and the same vertebra. In the first lumbar vertebra the diapophysis increases in thinness and decreases in length, presenting the form of a depressed plate; the other processes with thin articular surfaces are retained in both lumbar vertebræ. Parapophyses and metapophyses are also developed from the fore-part of the first sacral vertebra, together with another accessory process extending to the parapophyses, projecting from the fore-part of the diapophyses, and presenting an articular surface to a corresponding accessory articulating process for the anapophysis of the last lumbar. The neural spines of the five sacral vertebræ have coalesced into a continuous ridge, on each side of the base of which are the tubercular representations of the metapophyses. The transverse processes of the last sacral are enormously expanded, and develope from their under part a broad rough prominence for syndosmosis with the anterior tuberosity of the ischium. The posterior and ordinary tuberosity of that bone projects freely outwards beneath the transverse processes of the first caudal. The metapophysial tubercles begin to be developed from above the prozygapophyses from the first to the eighteenth caudal, beyond which the metapophyses exclusively represent the articular processes. The broad transverse processes have an accessory tubercle near their extremities, as far as the sixth caudal; at the seventh they are notched at their extremities, and the notch deepens until it divides the diapophyses into two in the eighteenth vertebra, and so on till they disappear at the end of the tail. Hæmal arches are articulated between the vertebral interspaces of most of the caudals.

In the Great Ant-eater (*Myrmecophaga jubata*), with *d* 15, *l* 3, the transverse processes of the atlas are pierced in two places obliquely at the fore-part of the neural

arch on each side. The axis has a transverse perforation on each side the neural arch anterior to the transverse process, which is imperforate. The transverse processes of the three succeeding cervicals are imperforate, the vertebral artery entering the neural canal behind and perforating obliquely the base of the neurapophysis anteriorly, as in the *Camelidæ*. In the sixth cervical, the canal for the vertebral artery runs through the base of the transverse process. These processes are much extended antero-posteriorly in all the cervicals and overlap each other. The diapophysial and pleur-apophysial portions are very distinct in the fifth and sixth cervicals. The spines of the third and sixth cervicals inclusive are triangular and pointed; that of the seventh is longer than the rest and truncate above; it is much exceeded in antero-posterior dia-meter by the spine of the first dorsal, but not in height. A metapophysial tubercle is developed from the outer side of the anterior zygapophysis in all the five posterior cervicals. It is placed more outwardly in the first and second dorsals, and gets upon the top of the diapophyses in the succeeding dorsals. In the eleventh dorsal the metapophysis (Plate XLIX. fig. 20, *m*) begins to resume its former position, and developes an articular surface (Plate L. fig. 21, *front, m a*) from its under part, which joins the upper articulating surface (Ib. *back, a m*) of the anapophysis (*a*) of the preceding vertebra. In the thirteenth dorsal, the metapophysis (*m*) is half-way between the diapophysis and anterior zygapophysis, and repeats the same articulation with the anapophysis. In the last two dorsal vertebræ, the base of the metapophysis developes a second articular surface (Plate L. fig. 22, *front, m z*) from its inner side, which joins a new or accessory articular surface (ib. *back, z'*) on the outside of the pos-terior zygapophysis of the antecedent vertebra. This tenon-and-mortise articulation of the metapophysis with the zygapophysis on the inner side and with the anapo-physis on the outer side, is repeated throughout the whole lumbar series. The an-apophysis (*a*) begins to be developed from the anterior dorsal vertebra, and even there presents an articular surface (Plate L. fig. 21, *back, a p*) at its under part to join a corresponding surface (ib. *front, p a*) on a parapophysis (*p*) developed from the fore and outer part of the neural arch of the succeeding vertebra. In the tenth dorsal a second articular surface (ib. *back, a m*) is established in the upper part of the anapophyses for the inferior metapophysial one (*m a*) of the succeeding vertebra; here, therefore, the anapophysis begins to be mortised between the parapophysial and metapophysial articular surfaces, which surfaces continue to the antepenultimate lumbar vertebra, from which, forwards, to the eleventh dorsal, there are sixteen joints between each pair of vertebræ, as in the Armadillo. But ths complication goes further in the Great Ant-eater, for, in the penultimate lumbar vertebra, a third articular surface (Plate L. fig. 23, *back, a d*) is developed from the under and outer part of the anapophysis (*a*), which joins an articular surface (fig. 23 *front, d a*) on the upper and fore-part of the diapophysis of the last lumbar; and this vertebra is united in a similarly complex manner with the first sacral vertebra, which would make eighteen synovial joints, in addition to those at the ends of tle centrum, but

that those between the normal articular processes, or zygapophyses, are suppressed. The true serial homology of the processes (*p. p.*) as 'parapophyses,' developed from the fore-part of the base of the neural arch to articulate with the under part of the anapophyses, is well illustrated by the vertebræ of the Great Ant-eater, and, as will be afterwards shown, in the Megatherium, in which the true diapophyses are better developed than in the Armadillos.

Definite terms for those several processes that undergo such remarkable modifications in the great *Edentata* become indispensable; they could scarcely be rendered intelligible by the ordinary descriptive periphrases. But, by means of single substantive names, all their modifications can be defined, and, by adjectival inflections of those names, the articular surfaces can be distinguished.

In figures 21, 22 and 23, Plate L., initial letters indicate the processes on one side, and the articular surfaces on the other side of each vertebra, thus :—

m is the metapophysis, with $m\,a$ its 'anapophysial,' and $m\,z$ its 'zygapophysial' articulations.

d is the diapophysis, w'th $d\,pl$ its 'pleurapophysial,' and $d\,a$ its 'anapophysial' articulations.

p is the parapophysis, with $p\,a$ its 'anapophysial' articulation.

a is the anapophysis, with $a\,m$ its 'metapophysial,' $a\,p$ its 'parapophysial,' and $a\,d$ its 'diapophysial' articulations.

z and z', in figs. 21 and 22, indicate the ordinary anterior and posterior zygapophyses; they become very small in the middle dorsal vertebræ, and are suppressed in the posterior dorsals and lumbars: the process z' in figs. 22 and 23 is not a gradual modification of the posterior zygapophyses, z' in fig. 21, but is a substitution for them, called out, as it were, by the new surface $m\,z$ upon the metapophysis.

As the complex structure of the vertebræ of the Armadillos and Ant-eaters has, hitherto, been sought to be illustrated by reference to the vertebræ of Serpents, it becomes necessary, after the foregoing analysis, to ascertain how far the analogy holds good.

The Ophidian reptiles so far resemble the *Mammalia* in their vertebral characters, that all the autogenous elements, except the pleurapophyses (Plate LI., fig. 31, 32, pl), coalesce with one another in the trunk, and the pleurapophyses (*ib.*, fig. 28, pl) themselves become anchylosed to the diapophyses (*ib. d*) in the tail. But the exogenous processes present many differences from those in *Mammalia*. The diapophysis (figs. 24 and 25, d) extends from the fore-part of the side of the centrum, and is large, vertically oblong or hemispherical (fig. 38, d), and very short: it is covered by the articulation for the head of the rib*. The base of the neural arch

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* This may be the 'head' of the rib in the same sense in which it would be said of that end of the simple rib which articulates wth the diapophysis in the hinder dorsal vertebræ of the Crocodile. Guided by this modification of the ribs in that reptile, the Anatomist would be led to the homology of the simple ribs, and of the

swells outward from its confluence with the centrum, and developes from each angle a transversely elongated zygapophysis; that (z) from the anterior angle looking upwards, that (z') from the posterior angle looking downwards, both surfaces being flat and almost horizontal. A wedge-shaped process, which I have termed ' zygosphene*' (fig. 25, z s), is developed from the fore-part of the base of the spine; the apex of the wedge being truncate or emarginate, and the converging sides presenting two smooth, flat, articular surfaces. This wedge is received into a cavity, which I have called ' zygantrum†' (fig. 26, z a), excavated in the posterior expansion of the neural arch, and having two smooth articular surfaces to which the zygosphenal surfaces are adapted. Thus the vertebræ of Serpents articulate with each other by eight joints, in addition to those of the cup and ball on the centrum; and interlock by parts reciprocally receiving and penetrating one another. This is the most conspicuous, but is not, as has been affirmed‡, the peculiar characteristic of the Ophidian vertebra; the zygosphenal (z s) and the zygantral (z a) surfaces being developed in certain Lizards, as e.g. the Iguana (Plate LI., figs. 40–42, z a, z s); where the zygosphene (z s, fig. 41) is deeply notched anteriorly, and the zygantra (z a, fig. 42) are shallow and separated from each other behind.

In the vertebræ of Reptiles and Mammals with double ' tenon-and-mortise' joints, the only articulating processes which are truly homologous are the zygapophyses (z, z' in all the figures) : the superadded processes in the Reptiles are, the zygosphene (z s) and zygantra (z a). A median ' tenon' and two lateral ' mortises' at the fore-part of the vertebra, and a median ' mortise' and two lateral ' tenons' at the back part of the vertebra, all of them above the true zygapophyses, are the result of the superaddition in Serpents; whilst in the Edentates a median mortise and two lateral tenons in front, and a median tenon and two lateral mortises behind the vertebra, are all of them below the true zygapophyses, and are the result of the additional processes called ' metapophyses' and ' anapophyses;' whilst a second pair of ' tenons

sustaining transverse processes in the Lacertians and Ophidians, which is indicated by the term ' diapophysis' applied to those processes. If, however, the lower articulating process in the bifurcated interior ribs of the Crocodile be not regarded as the superadded part, but as answering to the head of the simple rib in the Snake, then the transverse process to which this is attached will be a ' parapophysis,' and the postion of such transverse process in certain parts of the vertebral column, would lead to that supposition. But the modifications of the processes in question, in the Ophidian series, would indicate them to include, as in the Batrachia and in the neck of the Plesiosaurus, both diapophysis and parapophysis : and it is in this extended sense that I apply, for the sake of convenience, the term ' diapophysis' to the entire process in Ophidia and Sauria.

* Ζυγὸν, a yoke, σφὴν, a wedge.

† Ζυγὸν, and ἄντρον, a cavity.

‡ CUVIER, Leçons d'Anat. Comp. Ed. 1835, t. i. p. 216; where, after the double articular processes are described, it is stated, " Ces apophyses sont agencées de manière qu'il resulte, comme pour les vertèbres lombaires de certains Edentés, que deux vertèbres sont articulées entre elles par un double tenon entrant dans une double mortaise. La seule différence, c'est que les facettes de tenon et de la mortise supérieurs sont continues et forment entre elles un angle aigu." The complex joints are, however, formed by different processes in the Reptilia and Edentata, as is explained in the text.

and mortises' is superadded below the others, in some Edentates, by the special development of the anapophyses and of parapophyses.

I know not how these complex but constant characteristics differentiating the Ophidian and Mammalian vertebræ could be intelligibly made known without the use of 'names' for the parts; and, as I trust, that I have shown the parts to be not mere subdivisions of the diapophyses, but constant, characteristic, and independent processes, definite names for them cannot be reasonably deprecated as unnecessary *.

Before leaving this part of my subject, I may point out a few of the modifications of the exogenous processes of the vertebræ, by which different genera of *Ophidia* may be distinguished.

In the genus *Coluber* (Plate LI., fig. 29–32), the diapophysis, besides developing the articular tubercle (d) for the rib, sends a long process (d'') outwards above that tubercle, between it and the prozygapophysis (z), and a very short process (d'), like a parapophysis, downwards below that tubercle: the neural spine ($n\,s$) is low in proportion to its antero-posterior extent: the zygosphenal surfaces ($z\,s$) are nearly vertical, and the zygantra ($z\,a$) are wide apart: the hypapophysis (fig. 32, hy) beyond the anterior fourth part of the vertebral column is reduced to a straight ridge, and is not produced posteriorly.

In the Sea-Serpent (*Hydrus*) (fig. 33.), the diapophysis also sends out a process above and below the articular tubercle; but that which seems to underprop the zygapophysis, does not extend so far out as in the *Coluber*. The neural spine (fig. 33, $n\,s$) is higher in proportion to its antero-posterior extent: a very small hypapophysis projects below the articular ball of the centrum, and a low ridge is continued from it along the under part of the centrum.

In the *Naja* or Cobra di Capello, the neural (fig. 34, $n\,s$) spine is lower, but the hypapophysis (hy) is longer than in either of the preceding genera. The diapophysis presents a well-marked articular tubercle (fig. 35, d) upon its upper part, and both the upper (d'') and lower (d') processes are well-marked, although the former is shorter than in the genus *Coluber*.

The RattleSnake (*Crotalus*) (fig. 36–39) is remarkable for the development of the hypapophysis (h) to an equal length with the neural spine ($n\,s$) throughout the vertebræ of the trunk; such development being restricted to the anterior vertebræ in most other genera: and any single vertebra might be distinguished from an anterior trunk-vertebra of a Boa or Python, for example, by the following characters:— The diapophyis developes a small hemispheric tubercle (d) from its upper convexity; and a process (d') from its under part extending downwards and forwards below

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* See the criticism in 'Proceedings of the Zoological Society,' December 12, 1808, in which the author,— " Understanding that Professor Owen had proposed names for these mere subdivisions of the diapophyses, strongly deprecate the overloading this difficult part of anatomy with unnecessary names," p. 146; and yet he proceeds " to animadvert upon Cuvier and M. de Blainville for having neglected to describe them," as if they could be inteligibly described without determinations and names. What is truly to be deprecated is the unnecessary chang of names when once rightly applied.

the level of the centrum (c); the anterior zygapophysis (z) seems to be supported by a similar process (d'') from the upper end of the diapophysis, the point of which projects a little beyond the end of the zygapophysis (z, fig. 37) : I refrain from giving names to these upper and lower processes, because they really are nothing more than mere subdivisions of the diapophyses, and characterize the vertebræ of a few genera of a single order of Reptiles.

In the Boas and Pythons (fig. 24–27) the divisions (d'' and d') of the diapophysis are wholly wanting ; that process is entirely occupied by the articular surface for the rib, which is vertically oblong, convex in the axis of the centrum, and convex vertically at its upper half, but concave vertically at its lower half. The base of the neural arch swells outward, from its confluence with the centrum, and developes from each angle a zygapophysis, which is much longer transversely than in any of the preceding genera of Serpents (fig. 27, z, z'). The zygosphene (fig. 25, z s) is narrower in proportion to its height, and the zygantrum (fig. 26, z a) is correspondingly deeper and more circumscribed. In an African Constrictor (*Python regius*), which measured 15 feet 6 inches in length, and had 348 vertebræ, the first seventy had long hypapophyses, which afterwards subsided into the obtuse ridge and tubercle shown at fig. 27, hy.

Of the value of the minute and apparently insignificant modifications of the vertebral processes above described, some idea may be formed by their application to determine the nature and affinities of the great Serpent, of which the vertebræ have been found fossil in the eocene tertiary deposits of Kent and Sussex. The veritable Ophidian nature of the fossils in question is demonstrated, not only by the super-added zygosphenal (z s, fig. 45) and zygantral (z a, fig. 46) articulations, but by the solidity of the zygosphene, by the size and form of the centrum, by those of its articular cup (c, fig. 45) and ball (c', fig. 46), and of its hypapophysis (hy) ; and also by the size and prominence of the diapophysis (d). The largest vertebræ, probably from about the middle of the body, as compared with the vertebræ from the same part of the skeleton of a *Python Sebæ*, 20 feet in length, are longer in proportion to their breadth, and the cup and ball of the centrum are larger ; the hypapophysis (h) is more produced, and there is a second smaller hypapophysis close to the anterior part of the under surface of the centrum, which in most of the large vetebræ is connected by a ridge with the hinder and normal hypapophysis (fig. 47, hy), but in a few vertebræ is not so connected. The articular cup and ball are less obliquely placed upon the extremities of the centrum, being nearly vertical. The rim of the cup is sharply defined, and is more produced from between the bases of the diapophyses ; a deeper and narrower chink intervening than in the Python. The transverse diameter of the cup (c, fig. 45) is greater than that of the zygosphæe (*ib.*, z s),—a proportion which I have not found in the vertebræ of any existing gens of Serpent, in which the base of the zygosphene always equals at least the parallel diameter of the articular cup. The articular part of the diapophysis (d) is more produced out-

wards, and less extended vertically in *Palæophis* than in *Python*, and it is uniformly convex; a ridge is continued from its upper end obliquely forwards; as far as, but not beyond, the apex of the anterior zygapophysis (z), forming the angle between the lateral and anterior surfaces, whilst the horizontal articular facet forms the third surface of that three-sided conical process. In the *Python* the non-articular part of the same zygapophysis is convex, and the process is much more extended outwardly; the proportions of the zygapophysis in the *Palæophis* more resemble those in the *Coluber* and *Hydrus*, but differ from these, as also from *Naja* and *Crotalus*, in the non-extension of the diapophysial point beyond the articular surface.

A ridge or horizontal rising of the bone extends from the anterior to the posterior zygapophysis, but is more or less blunted or subsides midway, and is by no means so produced outwards as in Python; in this respect more resembling that in *Coluber* and *Hydrus*. Below the middle of this ridge, on a level with the upper surface of the centrum, there is a short, nearly parallel rising in *Palæophis* (fig. 44). The zygosphene (fig. 45, $z\,s$) is slightly excavated anteriorly, and shows no trace of the tubercle which characterizes the middle of that surface in the *Python* (fig. 25); it is also broader in proportion to its height. But perhaps the most characteristic feature of the vertebræ of the *Palæophis*, is the peculiar production of the posterior border of the neurapophysis into an angle (n, fig. 44) directed upwards, outwards, and backwards: there is no trace of this process in the *Hydrus* (fig. 33), or the other existing genera of Serpents. The posterior zygapophysis resembles, of course, the anterior one in its much less extent, especially transversely, as compared with that in the *Python*; and the posterior border of the neurapophysis (fig. 44, z', n) rises from its apex vertically, or a little inclined outwards and backwards, giving a squarish form to the surface of the neural arch in which the zygantra ($z\,a$, fig. 46) are ex-cavated; these cavities, in proportion to the articular ball beneath, are smaller and less deep than in the *Python*, or any other existing genus of Serpent. The sloping sides of the neural arch above the zygapophysial ridge are more concave than in *Python*, and so resemble those parts in *Coluber* and *Hydrus*. The latter genus (fig. 33) and *Crotalus* (fig. 36) most resemble *Palæophis* in the proportions of the neural spine ($n\,s$); this part, however, in *Palæophis* differs from that of *Hydrus* in having its base coextensive with the supporting arch, springing up from the fore-part of the zygosphene, whilst the zygosphene entirely projects forwards, clear of the base of the spine in *Hydrus*, as in *Python*, *Coluber*, and *Naja*; but in *Crotalus* the base of the spine has the same antero-posterior extent as in *Palæophis*. The neural spine had been more or less fractured in every detached specimen of the brittle crumbling vertebræ of the *Palæophis Typhœus* from the Bracklesham Clay;—only one specimen, which I carefully worked out in relief, from a mass of matrix, after imparting some of its original tenacity to the substance of the bone, afforded a true idea of the pe-culiar character of these Ophidian vertebræ, which is afforded by the great height of the neural spine, as shown in figure 44.

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Of the Hypapophysis.—Some idea of the nature and importance of this process may be formed by its constancy and range of variation in the Ophidian Reptiles, and especially by its degree of development in the genus* *Crotalus* (Plate II., fig. 36–39, *hy*), which is maintained throughout the vertebræ of the trunk. It is present, under various modifications, in certain regions of the vertebral column, in most other reptiles ; as likewise in Birds, and in a certain proportion of the mammalian class.

COITER seems first to have noticed this process in the Hare, and subsequent comparative anatomists have pointed out this peculiarity of certain lumbar vertebræ of the *Leporidæ*, as 'an inferior spinous process.' It is not, however, the inferior 'homotype,' or answerable part on the lower or ventral aspect of the vertebra, to the 'spinous process' above ; this is properly repeated by a true inferior or hæmal spine developed from the apex of the arch on the ventral aspect (Plate LIII., fig. 60, *h, h s*), which arch answers to the neural arch (*ib. n, n s*) on the dorsal aspect of the vertebra. The hypapophysis is a process commonly exogenous and always developed from the body of the vertebra, not from the hæmal arch. CUVIER applies the same term ' épine inférieure' to the exogenous processes from the centrum of the vertebræ of the Rattlesnake and Hare, and to the autogenous hæmal spines in Fishes.

In the Hare (*Lepus timidus*) the hypapophysis appears as a ridge in the posterior dorsal vertebræ, is developed into a process in the last dorsal, rapidly increases in length in the first and second lumbar vertebræ, inclines forwards in the third, and is suddenly reduced again to a mere ridge in the fourth and following lumbars.

In the Rabbit (*Lepus caniculus*) it is a low ridge in the posterior dorsals : the ridge is produced into a low angle in the first lumbar ; becomes a longer and more slender process in the second lumbar ; inclines forwards at a more acute angle in the third lumbar than in the Hare ; and subsides to a mere ridge in the succeeding lumbars. There is a short hypapophysis from the middle of the inferior part of the ring of the atlas, in both the Hare and Rabbit ; and in most other Rodents. In the Guinea-pig (*Cavia porcellus*) a hypapophysis is developed from beneath both atlas and dentata.

The hypapophysial ridge is strongly marked upon the lumbar vertebræ in the genus *Dasyprocta* : but the most constant location of the inferior exogenous processes from the centrum is in the caudal region, where they are frequently associated with a hæmal arch and spine.

In the Cape Hare or Jerboa (*Helamys capensis*) the hypapophysis, n the middle caudal vertebræ, arises from the fore-part of the under surface of the centrum, and immediately bifurcates : in some of the vertebræ anterior to these, a hæmal arch is attached to the ends of the bifurcate hypapophysis : towards the end of the tail the hypapophysis appears as two short diverging processes.

The modification which consists in a single process becoming doubl, affects most of the exogenous processes in certain parts of the vertebral column in he vertebrate series. We have already seen that the metapophysis is double in the anterior

thoracic vertebræ of the Ornithorhynchus: the diapophysis, which is single in the trunk, not unfrequently becomes double in the tail; and the hypapophysis commonly undergoes the same modification in that region.

In the Australian Water-rat (*Hydromys chrysogaster*) there are two pairs of hypapophyses in the fifth to the tenth caudal vertebræ inclusive, in most of which the anterior pair, homologous with that in *Helamys*, are longer than the posterior pair. But in such an exceptional instance it is not necessary to multiply names for the superadded or rather subdivided processes; the purposes of correct and definite description being sufficiently answered, by distinguishing under the name '*hypapophysis*' those, commonly exogenous, inferior processes of the centrum, whether single or in pairs, from the autogenous hæmal arches and spines, with which they have usually been confounded.

In the anterior thoracic and the cervical region of Crocodiles and Lizards the hypapophysis is constant and commonly single, but I have met with fossil vertebræ of a Crocodile in which the cervical hypapophysis was divided in the median plane, so as to form a pair*. The basioccipital sends down a pair of hypapophyses in the *Iguana* and *Mosasaurus*†, as likewise in Ruminants. This bifid modification is more commonly found in the caudal vertebræ of Reptiles, as it is in Mammals; but in the *Iguanodon* some of the caudal vertebræ have the hypapophysis single, where, *e. g.* it supports the coalesced bases of the hæmapophyses of such vertebræ.

In the Saw-toothed Seal (*Leptonyx serridens*) the cervical and anterior dorsal vertebræ have a hypapophysial ridge, which, in the latter, is produced into a tuberosity: the lumbar vertebræ are characterized by a pair of hypapophyses from near the hinder end of the centrum.

In the *Phoca grœnlandica* the strong hypapophysial ridge of the lumbar vertebræ also divides into two tuberous processes. These processes indicate the great development of the anterior vertebral muscles, *e. g.* the ' longi colli' and 'psoæ'; and relate to the important share which the vertebræ and muscles of the trunk take in the locomotion of the Seal-tribe, especially when on dry land, where they may be truly called ' gasteropods,' in respect of their peculiar mode of progression.

The hypapophysis is pretty constantly developed in the cervical region of the Ungulate quadrupeds, especially in the artiodactyle division. It is single in the atlas of the Hippopotamus, but divides into two ridges, diverging as they extend backwards, and terminating in tuberosities in the second and third cervical vertebræ: in the fourth they begin to subside, and disappear in the fifth cervical vertebra. A pair of hypapophysial tubercles reappear in the third lumbar vertebra of the Hippopotamus.

In the great extinct Irish Deer (*Megaceros Hibernicus*) the hypapophysis is a

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* On Fossil Reptiles from New Jersey, Quarterly Journal of the Geological Society, November 1849, p. 380, pl. 10. fig. 2.

† *Ib.* pl. 10. fig 5.

strong single ridge developed into a tuberosity in most of the cervical vertebræ. The atlas has a hypapophysis in most Ruminants.

In the Musk-deer the dentata has a sharp hypapophysial ridge, extending from below the base of the odontoid to beyond its posterior surface, where it underlaps the next vertebra. A similar ridge, ending in a backwardly produced process, is developed from the two succeeding cervicals; beyond which the hypapophysis gradually subsides to the seventh cervical.

In the Camel (*Camelus bactrianus*) the atlas has no hypapophysis; but this commences as a ridge from the hinder half of the centrum of the dentata, expands as it proceeds backwards, and divides into two tubercles. In the third and fourth cervicals it is principally represented by the pair of posterior tubercles, which subside in the fifth cervical vertebra.

The dentata of the Giraffe has a strong hypapophysial ridge from near the forepart of its body.

In the Monotremes the atlas is remarkable for a modification of the hypapophysis, similar to that which it undergoes in the caudal vertebræ of most Mammals; it forms, *e. g.* a pair of processes which diverge from one another: in the succeeding cervicals the hypapophysis is single.

As the aim of the present communication is to demonstrate the individuality and distinctness of the exogenous processes, and their title to distinct names, the modifications of each in any given class will not be traced further than appears requisite to attain the proposed end: and I shall conclude the present notice of the exogenous processes in the Mammalian class, by applying the principles and nomenclature above defined to the description of some caudal vertebræ.

Plate LIII., fig. 60, is the first caudal vertebra of the *Myrmecophaga jubata*, in which the hæmapophyses *h h* are superadded and articulated to the hypapophyses *hy hy*, forming a hæmal arch: in the succeeding vertebræ the hæmapophyses coalesce at their lower ends, and develope a true inferior or hæmal spine. *n, n*, are the neurapophyses; *n s*, the neural spine; *z*, the zygapophyses, here coexisting with *m* the metapophyses. The transverse process is long and single on each side, and consists of an exogenous base or 'diapophysis,' *d*, and an anchylosed 'pleurapophysis,' *pl.*

Fig. 61, A, is an upper view of the seventh caudal vertebra of a Beaver (*Castor fiber*), where *n n* are the neurapophyses, which have ceased to coalsce with each other and complete the neural arch: *m m* are the metapophyses; *d d* are the anterior diapophyses, and *d' d'* the posterior diapophyses. Fig. 61, B, gives an under view of *d d* and *d' d'*, and of the hypapophyses, *h h*. Fig. 61, c, is the front view of the same vertebra, showing *n*, *m m*, *d d*, and *hy.*

Fig. 62, A, B, c, is the ninth caudal vertebra of the Kangaroo; *n' n'* are the neurapophyses, which, coalescing at *n*, form the neural arch, now reduced to its smallest dimensions: *m, m* are the metapophyses; all trace of zygapophyses or articular processes has now disappeared from both the neur- and met-apopyses: *d d* are

the anterior, and $d'\,d'$ the posterior diapophyses. These are, also, shown in the view of the under surface of the same vertebra, fig. 62, B, in which the hypapophyses hy, hy are figured. Fig 62, C, gives an anterior view of the centrum with $m\,m$ the metapophyses, $d\,d$ the anterior diapophyses, and hy the hypapophyses, diverging from it, as exogenous processes. The neurapophyses $n\,n$ and the posterior diapophyses $d'\,d'$ are also seen.

Many excellent figures of the caudal vertebræ of different species of Mammalia are given in the 'Ostéographie' of M. DE BLAINVILLE, the characters of which may be readily understood by the above definition of the processes that diverge from them.

In the class *Aves*, the hypapophyses attain their maximum of development and range of variation in the Penguins (*Aptenodytes patachonica*, Plate LII., fig. 48). Single and long on the first four vertebræ of the neck, especially on the dentata, their place is taken by a pair of short processes in the sixth cervical, which processes increase in size in the four following vertebræ, converging in the last ($h\,h$, c 10) so as almost to complete a bony canal for the carotids: in the eleventh cervical (c 11) they have coalesced again into a single median plate, with its extremity extended both forwards and backwards; this plate decreases in the three following vertebræ. In the next, which may be regarded as the first dorsal, the hypapophysis again appears as a pair of processes (D 1, $h\,h$); both of these are broad plates, almost coextensive with the under surface of the vertebra and diverging from each other (fig. 49, hy). The common base of the diverging plates progressively lengthens in the second (fig. 50) and third dorsals, and the hypapophysis appears in the succeeding ones as a strong vertical plate, simply expanded at its end, and growing somewhat shorter to the last (fig. 51, D 4, hy).

In the *Sphæniscus minor*, the first dorsal vertebra, or the fourteenth vertebra from the head, presents three hypapophyses, which appear to be blended together in the next vertebra so as to form the common base of a pair of diverging plates. The hypapophyses in the Penguins have an analogous function to that in the Seals, extending the surface of attachment of the powerful muscles on the ventral aspect of the vertebral column, which so materially aid in the shuffling gasteropodal movements of both kinds of aquatic animals, when on land.

The hypapophysis is well-marked in the anterior cervical vertebræ, especially the dentata, in most birds: it usually reappears, as a pair of processes, from the parapophyses of the lower cervicals; which hypapophyses converge as they approach the dorsal region and coalesce into a single process in the anterior vertebræ of this region, and in some birds in the lower cervicals.

In the Pelican, the parial hypapophyses coalesce at their lower extremities, and form a hæma arch for the carotids in many of the lower cervicals.

The anterior trunk-vertebræ in many Siluroids are anchylosed by a hypapophysial development of bone continued from beneath one vertebra to another, and which is sometimes perforated lengthwise by a canal lodging the aorta*. The neck of the

* On the Archetype of the Vertebrate Skeleton, p. 92.

Ichthyosaurus derives additional strength and fixation from hypapophyses autogenously developed, at the inferior interspace between the occiput and atlas, and at those between two or three succeeding cervical vertebræ*. The so-called 'body of the atlas,' in recent Saurians, Birds, Mammals and Man, is the homologue of the first of these subvertebral wedge-bones, and represents only the hypapophysial or lower cortical part of such body. The odontoid process of the second vertebra is the central and chief part of the body of the atlas†, but not the whole body, as CUVIER describes in the fimbriated Tortoise‡.

The most interesting and instructive steps in the transition of this main part of the centrum of the atlas to the modified condition which it presents in Man, and which is signified by the term 'processus odontoïdes' in HumanAnatomy, are exemplified in the order *Chelonia*. In the Australian Long-necked Tortoise (*Hydraspis longicollis*, BELL), I find the centrum (*c c*, figs. 57, 58, Plate LII.) completely anchylosed with the neural arch (*n*) of the atlas, with the exception of the hypapophysis (*hy*), which is autogenous in this vertebra and preserves its distinctness. In the Soft-turtles (*Trionyx*) (*ib.* figs. 52, 53 and 54) both the centrum and hypapophysis of the atlas maintain their primitive individuality: the centrum (*c*) is relatively shorter than in the *Chelys* and *Hydraspis*; it presents a subcubical form, has a small sub-circular surface (*c*, fig. 55) on its lower and fore-part for articulating with the hypapophysis; above this it expands transversely and presents a convex articular surface adapted laterally to the bases of the neurapophyses, and, mesially, completing the cup for the occipital condyle, and filling up the vacancy shown at *c*, fig. 53: the back-part presents a concave surface (*c*, fig. 56) which articulates with the anterior convexity of the centrum of the dentata. The neurapophyses of the atlas (fig. 54, *n*) rest partly upon their proper centrum (*c*), partly upon its hypapophysis (*hy*): their bases nearly meet above the centrum, and their apices quite meet, uniting by suture above the neural canal (fig. 53). The degradation of the centrum of the atlas to the odontoid process of the axis is completed by its confluence with the centrum of the latter vertebra, and by the total transference of the neurapophyses of the atlas to the hypapophysis. Fishes, Batrachians and the extinct Enaliosaurians, manifest the typical state of the atlas, the Warm-blooded Vertebrates its aberrant state, the transitional modifications are traceable in the Chelonian, Lacertilian and Ophidianreptiles§.

When the hypapophysis attains so complex a form as to be perforated and thus to constitute an arch protecting a vascular canal, it may readily be mistaken for something more than the mere *analogue* of the 'hæmal arch' of the typical vertebra; and, in my earlier investigations on that subject, I was led into the error‖ of regarding it

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* Sir PHILIP DE MALPAS GREY EGERTON, Bart., F.R.S., in Geol. Trans. 2nd Ser. vol. v. p. 187, pl. 14.

† Annals of Nat. History, vol. xx. 1847, p. 92.

‡ Ossemens Fossiles, tom. v. pt. ii. p. 207.

§ See the description and figures of the atlas and axis of the Python in my 'History of Britis Fossil Reptiles,' Part III. p. 136, pl. 3 (*Ophidia*), figs. 38—40.

‖ Geol. Transactions, vol. v. 2nd Ser. p. 519, pl. 44, figs. 2 and 3.

as the *homologue* of that arch. The perforated hæmal arch in the cervical vertebræ of the Pelican, and the parallel descending processes similarly protecting the caudal artery in the Python (Plate LI., fig. 28), are alike exogenous growths from the centrum, and are serially homologous with the hypapophysis, not with the hæmapophysis. The total absence of true ossified hæmapophyses throughout the trunk and tail vertebræ, is a striking characteristic of the Ophidian reptiles*, as it is of fishes.

The determination of the homology of the autogenous hæmal arches in the tail carries with it that of the question of their relation to the inferior and sometimes perforated exogenous processes of the centrum in more advanced parts of the vertebral column.

The vast difference in point of size between the so-called ' chevron-bone' of the Crocodile and the bony arch formed by the sternal and vertebral ribs of a thoracic vertebra, seems at first sight to discountenance the idea of any homology between them. But the difference is not greater than that between the neural arch of the parietal segment of the skull in Man, and the arch formed above the middle dorsal vertebra: yet I think it may be now assumed as a settled point in anatomy, that those arches are homotypes or serial homologues. The difference in point of size is, indeed, much less in the cold-blooded and small-brained Vertebrates than in Man; but the transition from the abdominal to the caudal hæmal arches in fishes is much more gradual than that of the cranial to the abdominal neural arches in the same class, whilst the similarity of the neural and hæmal arches to one another is so close throughout the region of the tail, as to impress the mind with a conviction that they are alike the result of modified annular elements, in short, ' vertical homotypes.' CUVIER, accordingly, designates them by the same descriptive phrases†.

The general proposition that the ' chevron bones' or ' inferior annular part and spine' of the vertebræ in the tail of fishes, are modifications of the hæmal arches in the trunk, may be deemed to be unassailable. But the hæmal arch is a complex whole, and may include diapophyses or parapophyses with pleurapophyses, hæmapophyses and hæmal spine. In the abdomen of fishes the bony arch is incomplete below, and in its most complex state consists only of parapophyses and pleurapophyses. With the exception of the clavicular and pubic arches, bony hæmapophyses are developed in no part of the trunk of fishes. When, therefore, we rigidly scrutinize the composition of the hæmal arches in the tail, we find them composed of parts quite distinct from true hæmapophyses, and also composed of different vertebral elements in different species of fishes, a fact which adds to the proof of the essential serial homology of those arches in the tail with the hæmal arches in the trunk. In many osseous fishes the hæmal arches in the tail are formed by the gradual bending down and coalescence of the parapophyses: in some the union

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* Cartilaginous appendages to the pleurapophyses in Serpents may be viewed as rudimental ' hæmapophyses.'

† " Les caudales ont une partie annulaire et une apophyse épineuse en dessus et en dessous." CUVIER, ' Leçons d'Anat. Comp.' Ed. 1835, t. i. p. 223.

is effected by a transverse bony bar prior to the actual confluence of those pro-
cesses, and pleurapophyses continue to be attached to some of the parapophyses after
their transmutation into the hæmal arches, as *e. g.* in the Tunny, the Dory and the
Salmon*. Nevertheless, in the Salamandroid *Polypterus* and *Lepidosteus*†, and in the
nearly allied *Protopterus* and *Lepidosiren*, the true pleurapophyses gradually bend
down and unite to form the hæmal arches in the tail; whilst in the *Amia calva* the
pleurapophyses coalesce to form the inferior spine, continued from the hæmal arch,
formed by the coalesced parapophyses‡. In the Cod-tribe (*Gadidæ*) the progressively
reduced pleurapophyses coalesce with the parapophyses to form the hæmal arches.
In Ophidians, as in Fishes, the transition from the trunk to the tail is not interrupted
by the modification of any of the vertebral segments to form a 'pelvis.' The ribs
are supported by diapophyses, with which they become confluent in the tail, where
some of the pleurapophyses are singularly modified, bifurcate or thickened at the
extremity, but never bent down and united together to form the hæmal arch: as
there are no bony hæmapophyses completing the hæmal arch in the trunk, the suc-
ceeding segments of the tail retain, or have been influenced by, the same modifica-
tion of vertebral development, and the analogue of the hæmal arch is formed, as I have
before observed, by a pair of parallel exogenous hypapophyses (Plate LII., fig. 28, *hy*),
and is open below, like the incomplete hæmal arches throughout the trunk. In
Lizards and Crocodiles a new vertebral element appears to be introduced to com-
plete the hæmal arch in the chest; it is, however, only a repetition of an element
which, under a more developed and modified form, completes the hæmal arches in
the head, in both fishes and reptiles, viz. the 'hæmapophysis:' this element is called
'upper' and 'lower jaw' and 'horn of the hyoid' in the head, 'sternal rib' or 'cartilage
of the rib' in the chest: the same element is retained to form the 'pelvis,' where it is
called 'pubis' and 'ischium'; and it is continued as a distinct pair of bones in the
beginning of the tail in the Great Ant-eater (Plate LIII., fig. 60, *h h*), and throughout
a great part of the tail in the *Ichthyosaurus* and *Plesiosaurus*; whilst the pair of
hæmapophyses become confluent at their distal ends, and form the so-called chevron-
bones in the Crocodile, and most other Saurians. Under all these modifications the
hæmapophyses coexist with pleurapophyses in the thorax, the pelvis and the tail;
only in the latter region the pleurapophyses become anchylosed to the diapophyses
or to the centrum, and stand out as 'transverse processes' (fig. 60, *d, pl*). The
sudden diminution in the size of the hæmal arch in the tail, as contrasted with its
expanse in the pelvis, is apt at first to excite some doubt as to the serial homology of
the 'chevron bones' with the 'ischia' and 'pubes'; but when we compare them in a
species, as *e. g.* the Mole (*Talpa*), in which the hæmal arch in the pelvis is limited to

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* Cuv. l. c. p. 224.

† Müller, Ueber den Bau und die Grenze der Ganoiden, und über das naturliche System der Fische,
1844.

‡ " Omnes arcus inferiores spinam gerunt e costis concretis formatam."—Franke, 'Nonnulla ad Amiam
Calvam accuratius cognoscendam.'

Fig.1.

Fig. 2.

Homo

Felis concolor.

Macacus nemestrinus

Fig. 5.

Fig. 4.

Fig. 6.

Fig. 7.
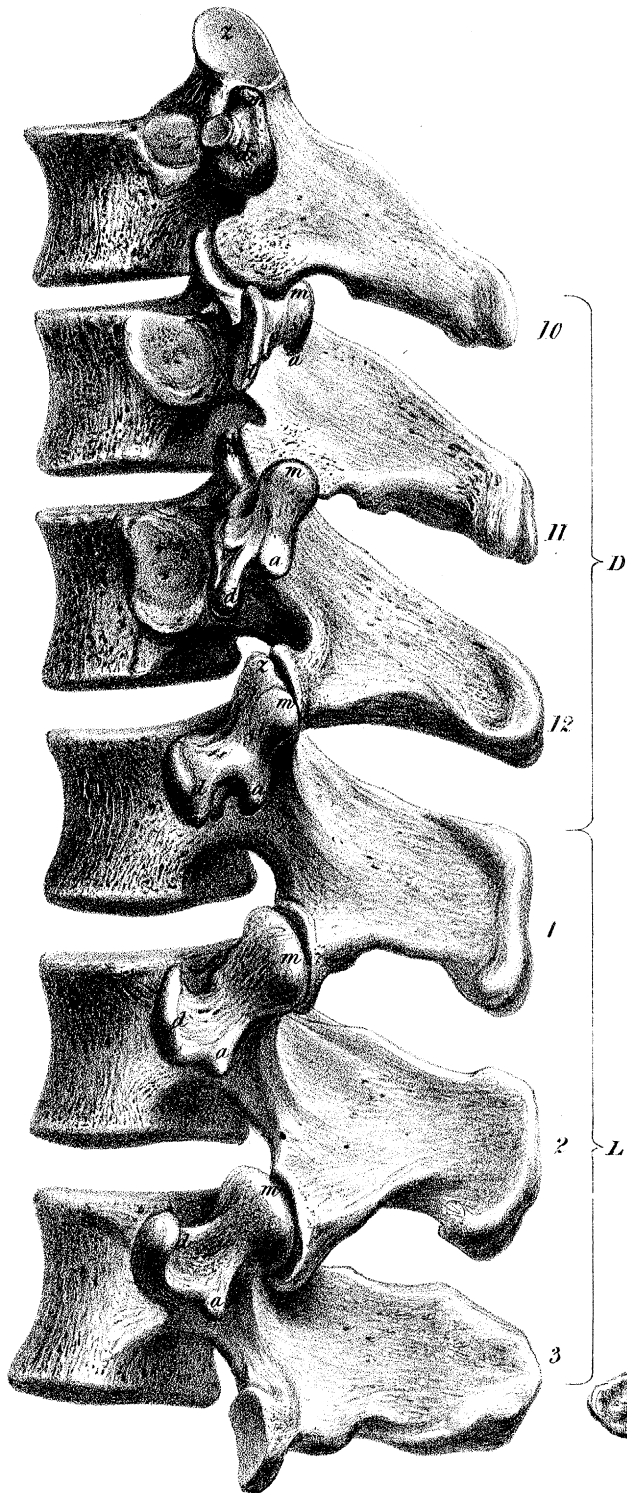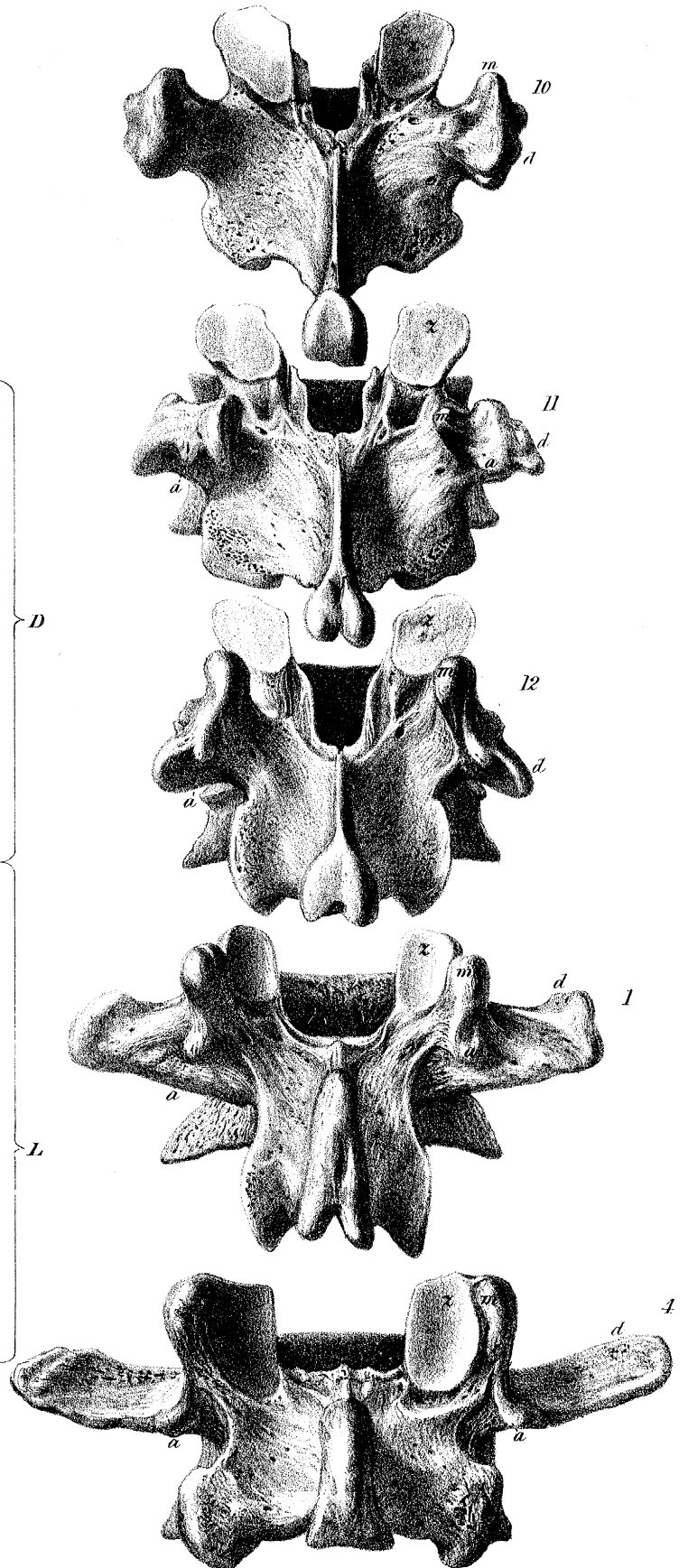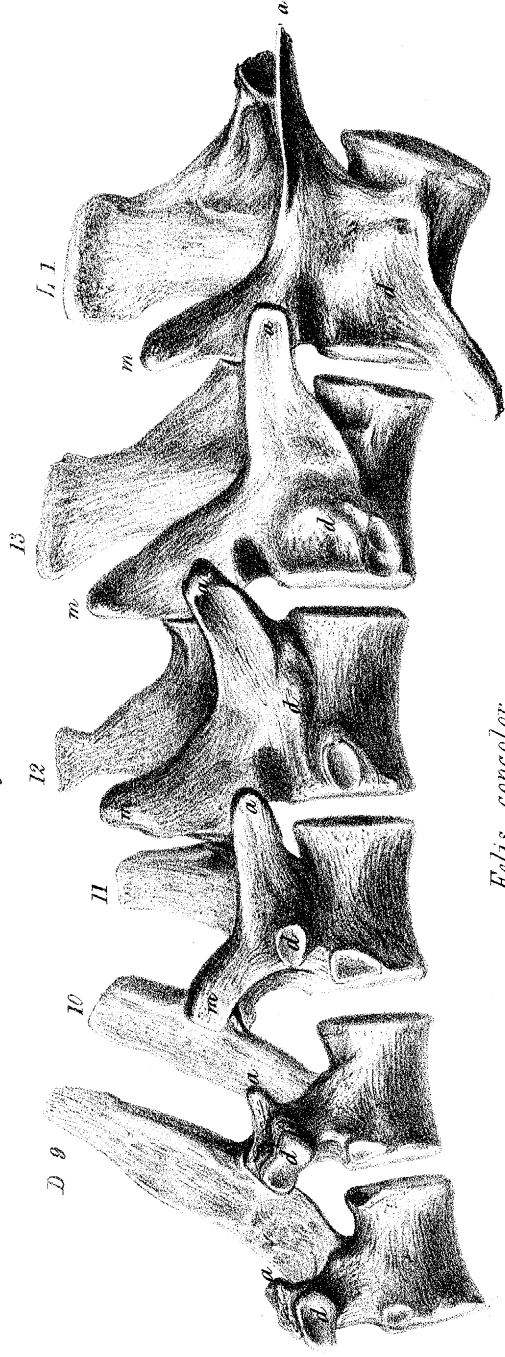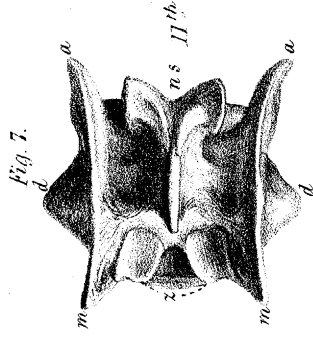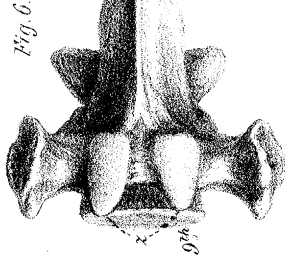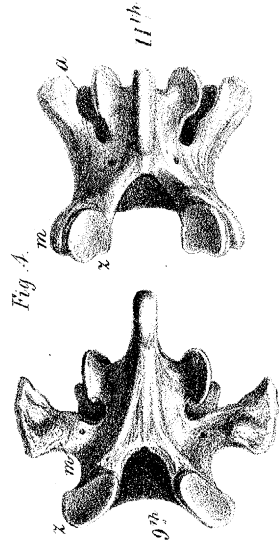
Fig. 3.
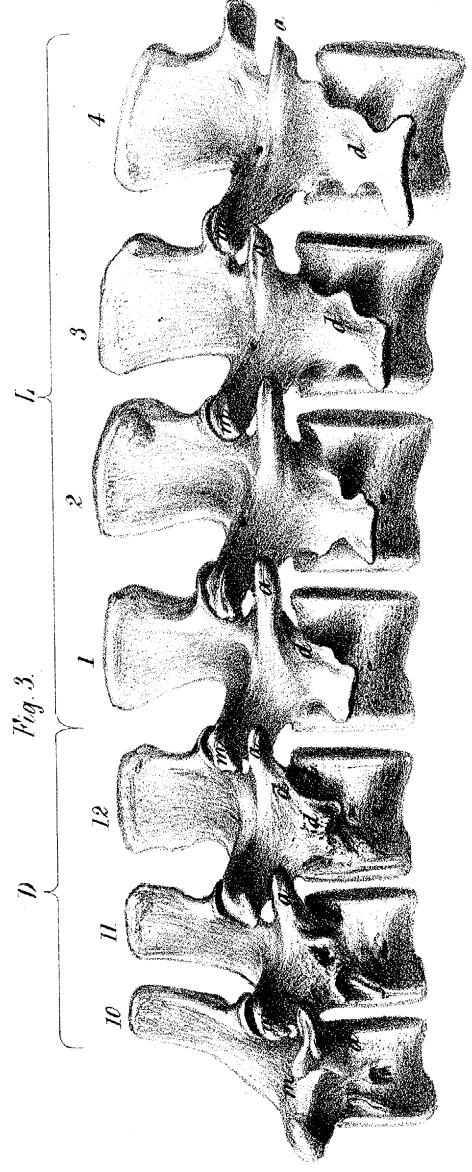
the same protective functions as it performs in the tail of other quadrupeds, we find it reduced to the same small area or vertical dimensions, and applied close to the centrum, and the difficulty disappears. As the hypapophyses usually coexist with and support the hæmapophyses, when these are present in the tail of a reptile or mammal, they cannot be 'homologous' in any sense, and the hypapophyses are only 'analogous' when they happen to be perforated by the carotid arteries, as in the cervical vertebræ of some birds, or when they include the caudal artery and vein, as in the tail of Serpents. No one can confound the parapophyses or inferior transverse processes (Plate LII., fig. 52, p) with the hypapophyses (ib. h), who has observed them as they coexist in the cervical vertebræ of a Crocodile; and the hypapophyses are equally demonstrated to be distinct from the hæmapophyses by the presence of both in the tail of the *Myrmecophaga jubata* (Plate LIII., fig. 60, *hy, h*).

DESCRIPTION OF THE PLATES.

In each figure the same processes are indicated by the same letters.

m. Metapophysis.	*d.* Diapophysis.
a. Anapophysis.	*p.* Parapophysis.
z. Zygapophysis.	*hy.* Hypapophysis.

PLATE XLIV.

Fig. 1. The three last dorsal and three first lumbar vertebræ of a Frenchman. Side view.

Fig. 2. The three last dorsal, first and fourth lumbar vertebræ of the same, from the dorsal aspect.

PLATE XLV.

Fig. 3. The three last dorsal and four first lumbar vertebræ of the Brown Monkey (*Macacus nemestrinus*), from the side.

Fig. 4. The tenth and eleventh dorsal vertebræ of the same, from the dorsal aspect.

Fig. 5. The five last dorsal and first lumbar vertebræ of the Puma (*Felis concolor*). Side view.

Fig. 6. The ninth dorsal vertebra of the same, from the dorsal aspect.

Fig. 7. The eleventh dorsal vertebra of the same, from the same aspect.

PLATE XLVI.

Fig. 8. An oblique upper view of the tenth, eleventh and twelfth dorsal vertebræ, to show the distinctness of the metapophysis (*m*) from the zygapophysis (*z*) and the diapophysis (*d*), and the gradual change of position of the metapophysis (*Leptonyx serridens*).

Fig. 9. The last five dorsal and the lumbar vertebræ of the *Helamys capensis*. Side view.

Fig 10. The ninth and tenth dorsal with the second and third lumbar vertebræ of the *Lagotis Cuvieri*. Side view.

PLATE XLVII.

Fig. 11. The last seven dorsal vertebræ of the Capybara (*Hydrochœrus Capybara*), from the dorsal aspect, chiefly to demonstrate the distinction between the metapophyses (*m*) and the prozygapophyses (*z*).

Fig. 12. The twelfth, fourteenth and fifteenth dorsal vertebræ, and the first and second lumbar vertebræ of the Wombat (*Phascolomys Wombatus*), from the dorsal aspect, to show the serial homology of the diapophysis (*d*), and the partially anchylosed rib (*pl*) of the first lumbar vertebra (L 1).

Fig. 13. The last four dorsal vertebræ, the lumbar vertebræ and sacrum of the *Macropus Parryi*, side view, showing the abrupt commencement of the metapophyses (*m*) on the twelfth dorsal, the comparatively small size of the anapophyses (*a*); and the distinctness and persistency of the diapophyses (*d*) in the posterior dorsal vertebræ.

PLATE XLVIII.

Fig. 14. The last eight dorsal vertebræ and first lumbar vertebra of the Musk-deer (*Moschus moschiferus*), showing the progressive development and change of position of the metapophysis (*m*); the serial homology of the dorsal and lumbar diapophyses (*d*); and the anomalous development of the pleurapophysis (*pl'*) of the fourteenth vertebra from the neck. Side view.

Fig. 15. The fourth, sixth, seventh, twelfth and fourteenth dorsal vertebræ of the *Delphinus Tursio*, from the dorsal aspect, showing the gradual supercession of the prozygapophyses (*z*), by the metapophyses (*m*).

Fig. 16. The eleven anterior dorsal vertebræ of the *Delphinus Delphis*, showing the sudden beginning and progressive ascent of the *metapophysis* (*m*) in that part of the vertebral column; also the progressive elongation of the diapophysis (*d*).

PLATE XLIX.

Fig. 17. The last two dorsal and first lumbar vertebræ of the Three-toed Sloth (*Bradypus tridactylus*), from the dorsal aspect.

Fig. 17*. The last six cervical and first two dorsal vertebræ of the *Echidna hystrix*, showing the distinct short and thick pleurapophyses (*pl'*) of the neck, still articulating with the diapophysis (*d*) and parapophysis (*p*).

　　　The body of the atlas (*c a*) has not yet coalesced, as the ' odontoid process,' with the dentata.

Fig.8.
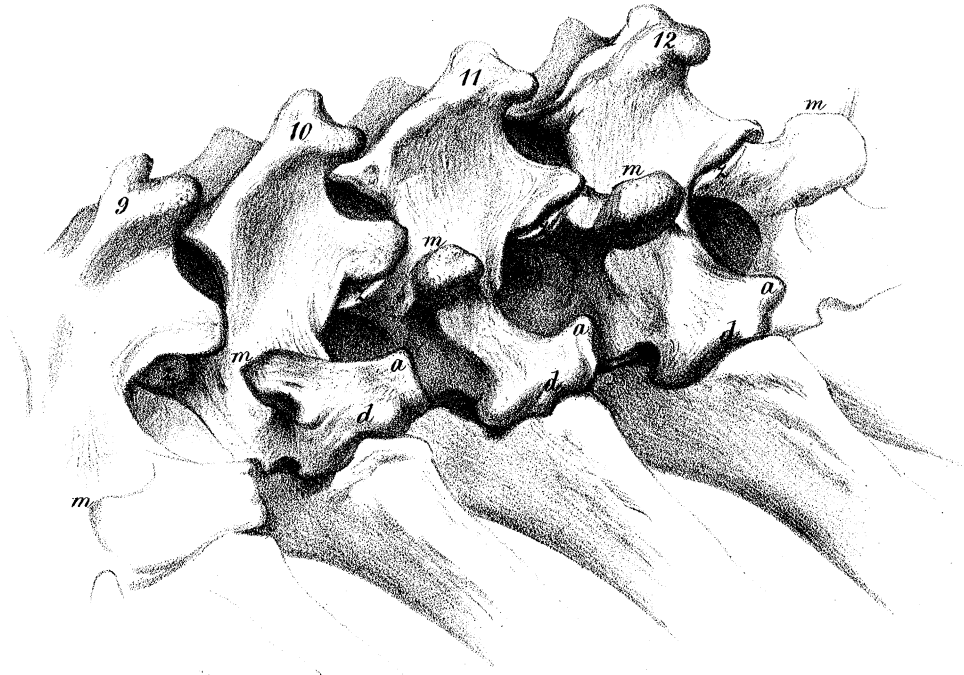
(Leptonyx) Phoca serridens.

Fig. 9.
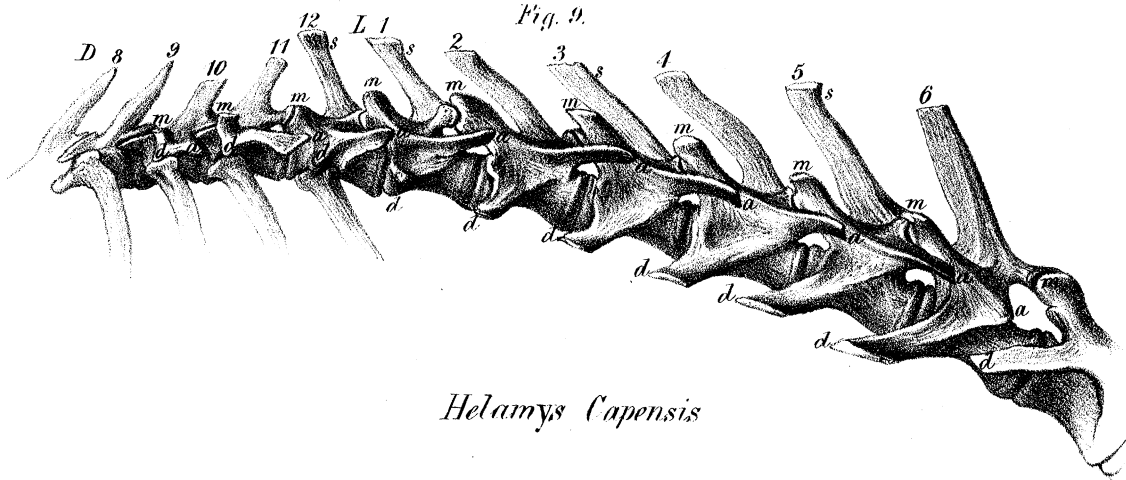
Helamys Capensis

Fig. 10.
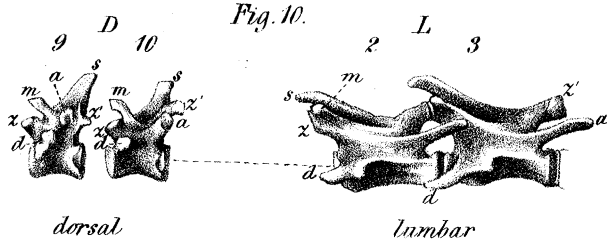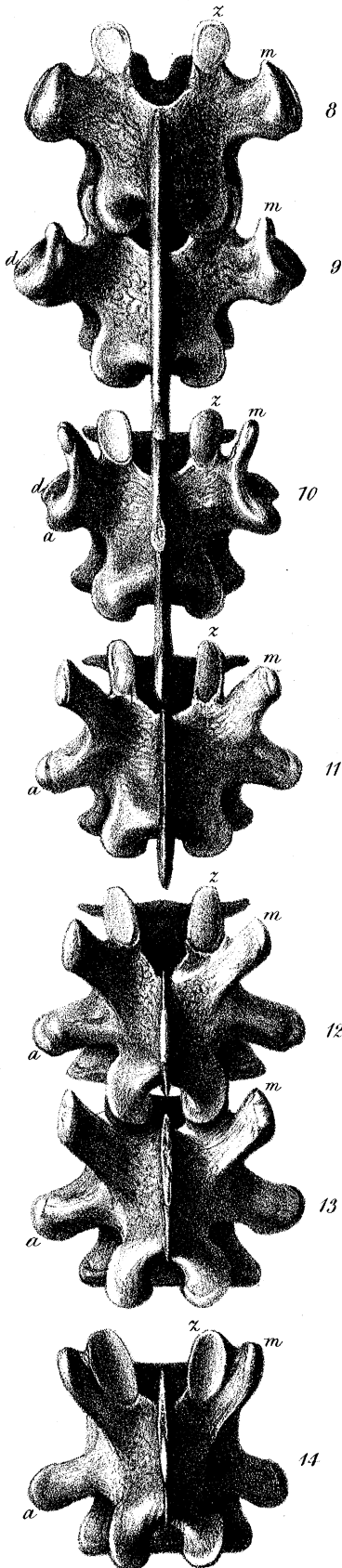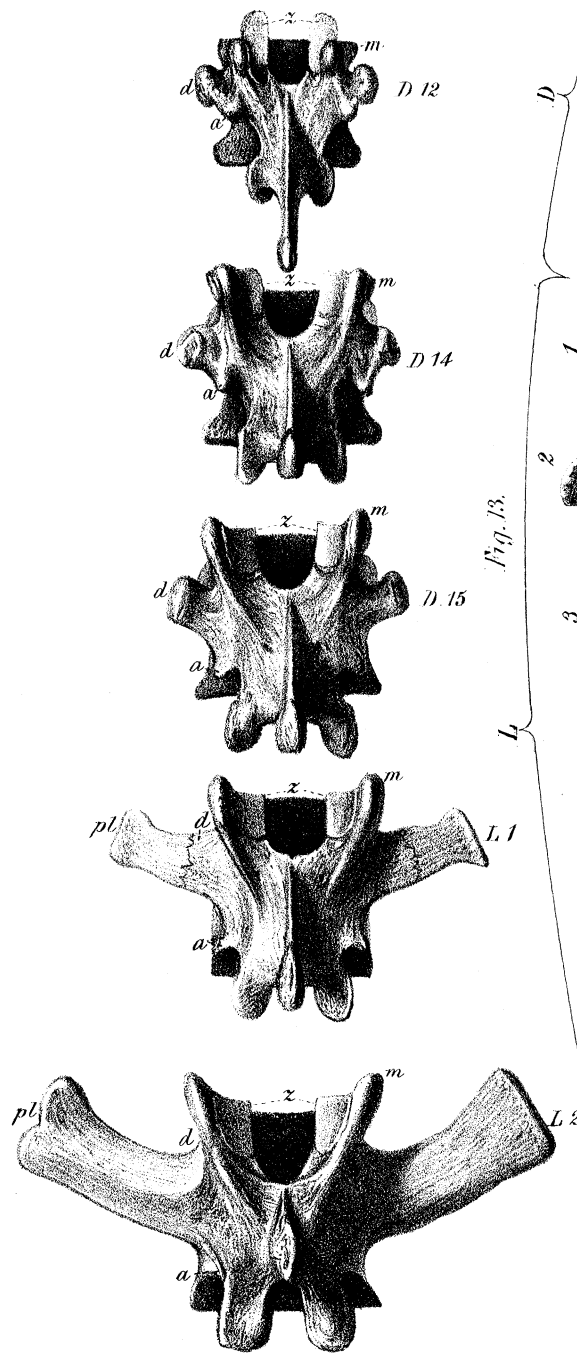
dorsal   lumbar

Lagotis

Fig.11.

Fig.12.

Fig.13.

Macropus Parryi

Phascolomys Wombat

Hydrochærus Capybara
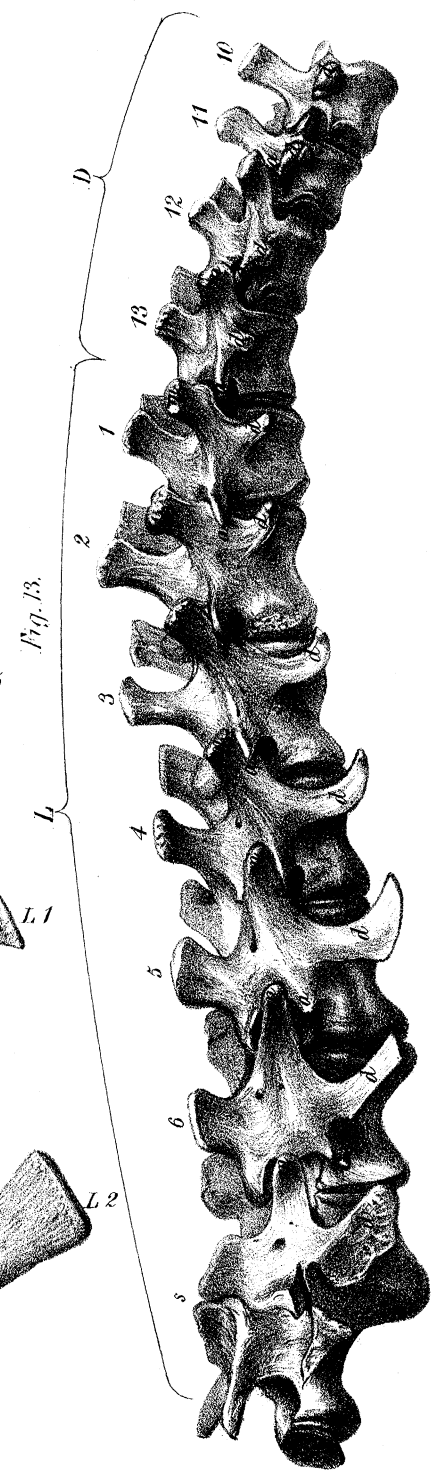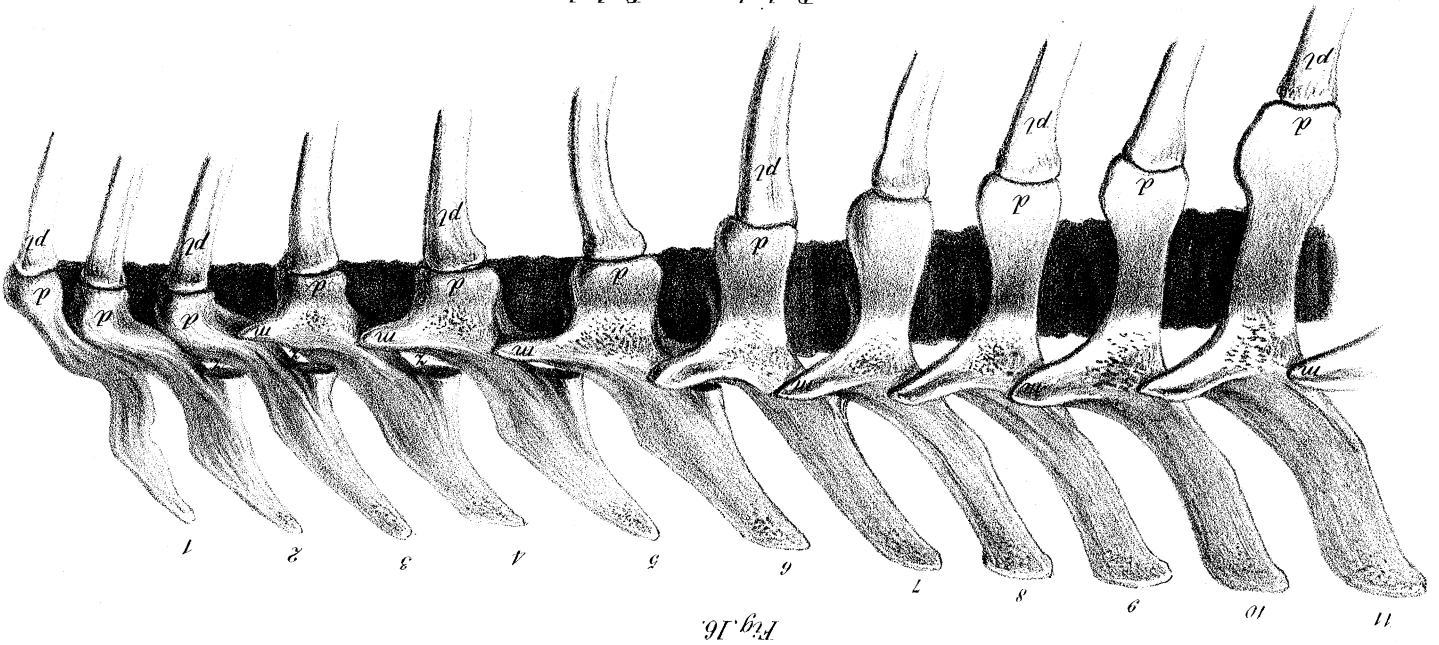
Delphinus Delphis.

Fig.16.
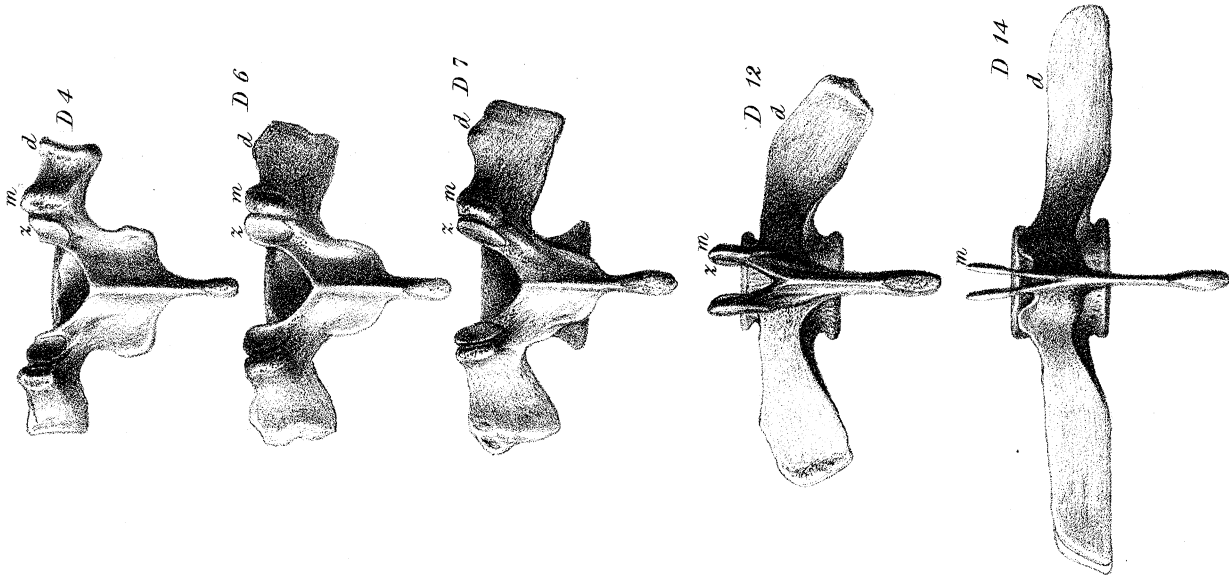
Fig.15.

Delphinus Tursio.
½ nat. size.

Fig.14.
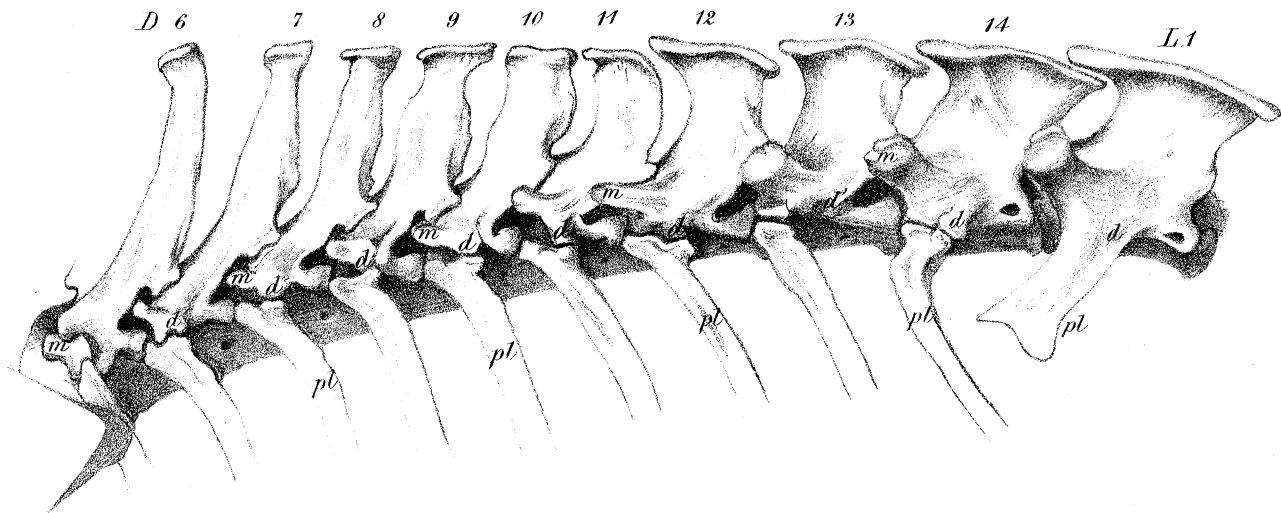
Moschus moschiferus.

Fig. 17.

Bradypus tridact.ˢ

Myrmecophaga jubata.

Echidna

17*
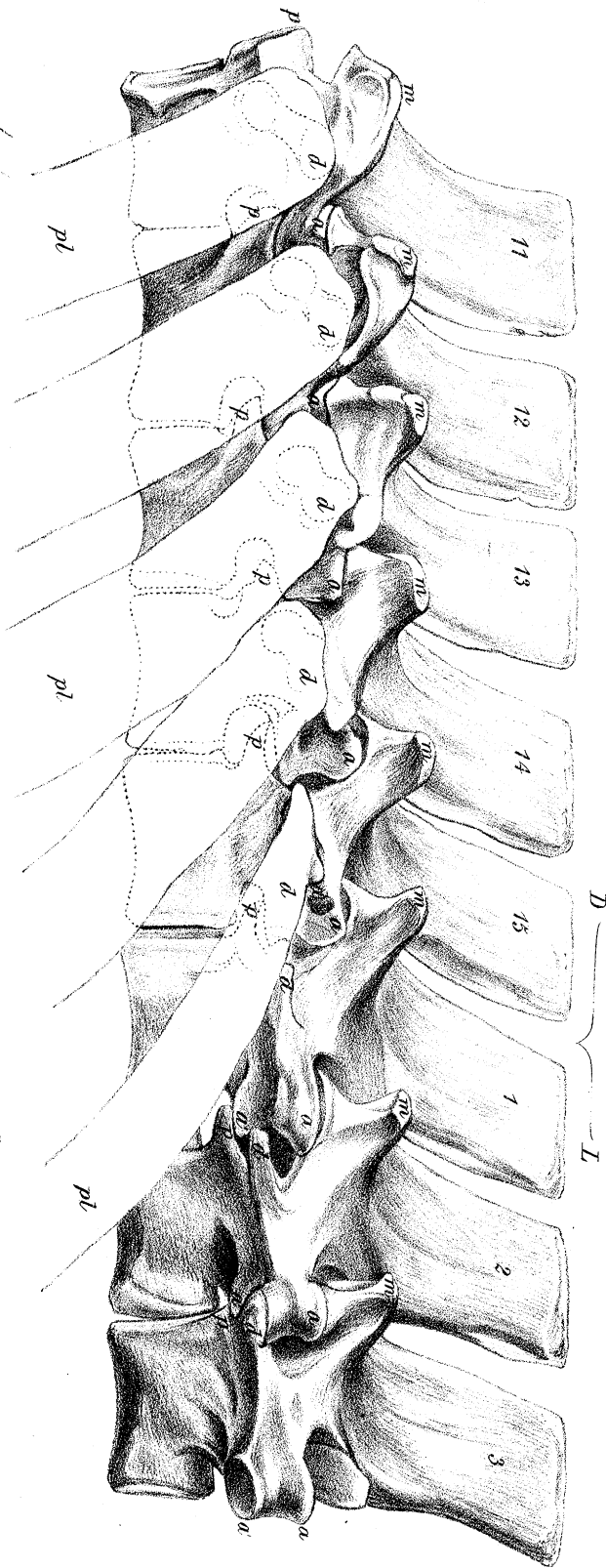
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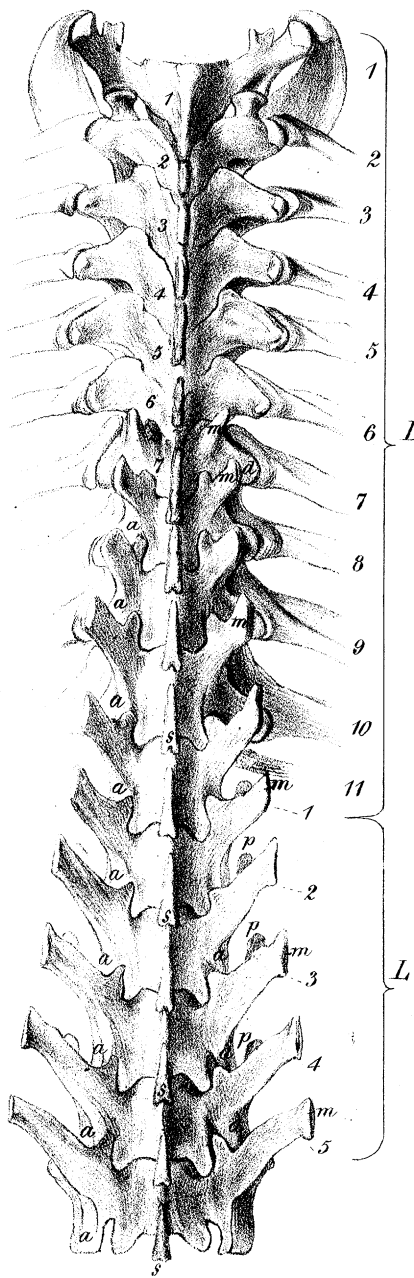
Dasypus longicaudus
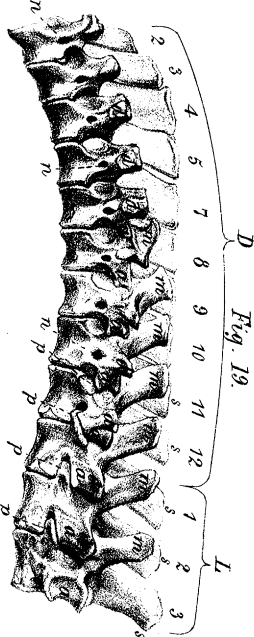
Dasypus tricinctus
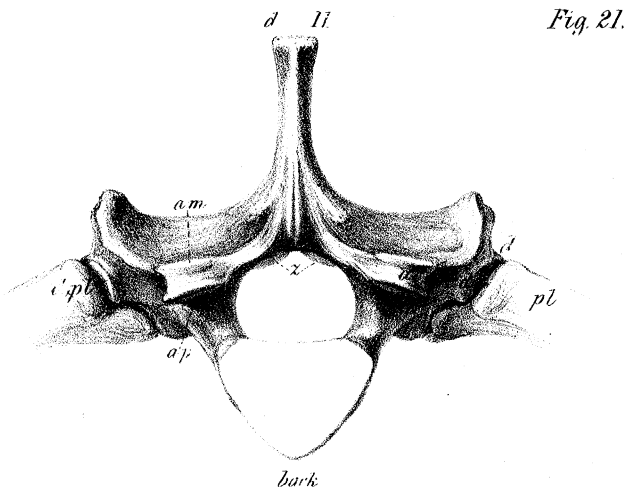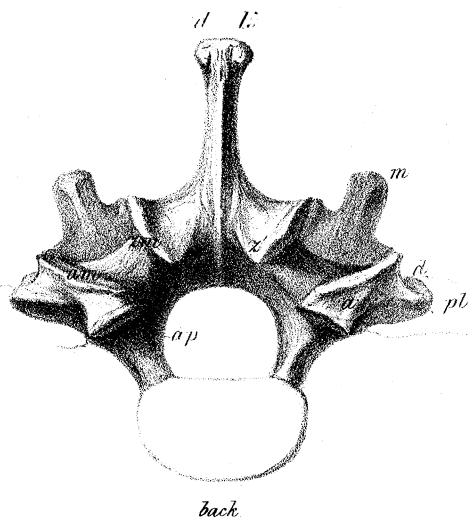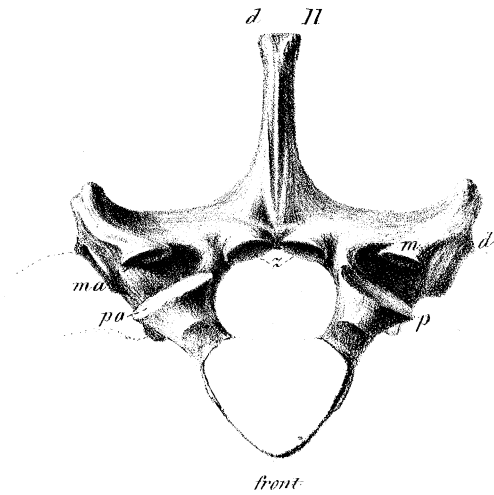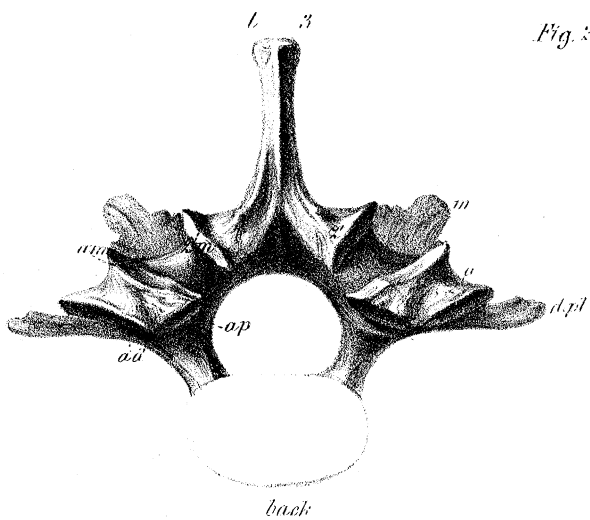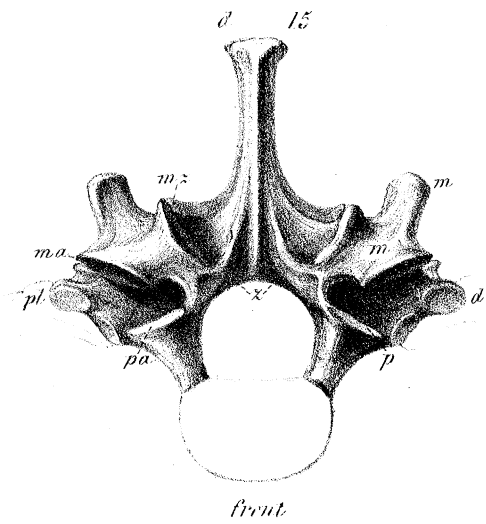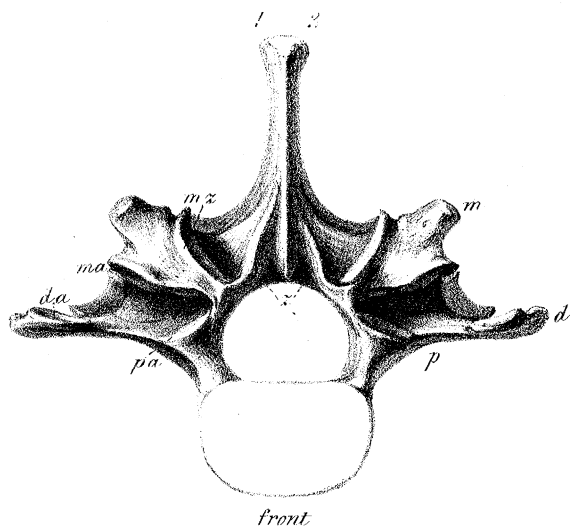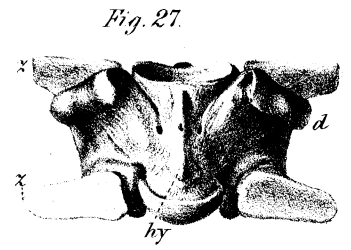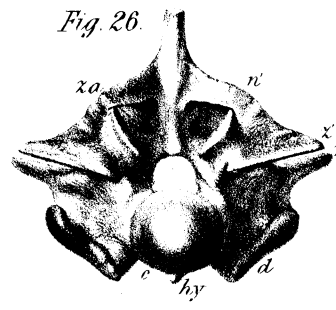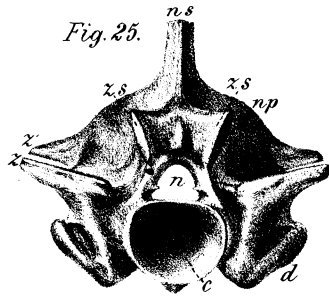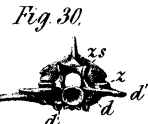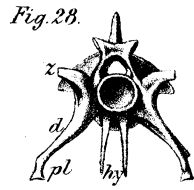
Fig. 19.

Fig. 20.

Fig. 21.

back

front

Fig. 22.

back

front

Fig. 23.

back

front

Myrmecophaga jubata.

Fig. 24. Fig. 25. Fig. 26. Fig. 27.

Python

Fig. 27′ Fig. 28. Fig. 29. Fig. 30. Fig. 27′

Python Coluber

Fig. 31. Fig. 32. Fig. 33. Fig. 34. Fig. 35.

Coluber Hydrus Naja

Fig. 36. Fig. 37. Fig. 38. Fig. 39. Fig. 40.

Crotalus Iguana

Fig. 41. Fig. 42. Fig. 43.

Iguana

Fig. 44. Fig. 45. Fig. 46. Fig. 47.
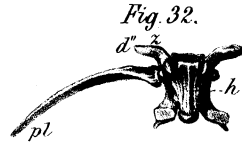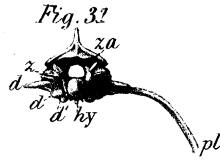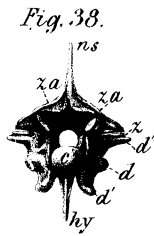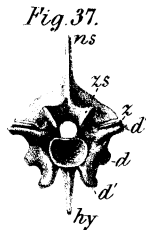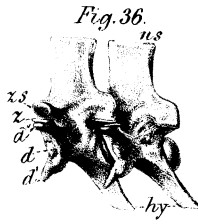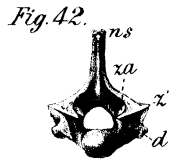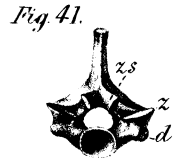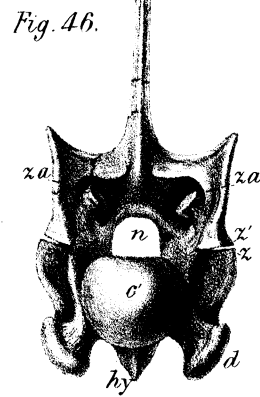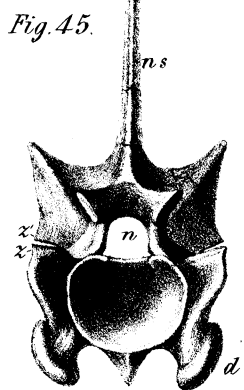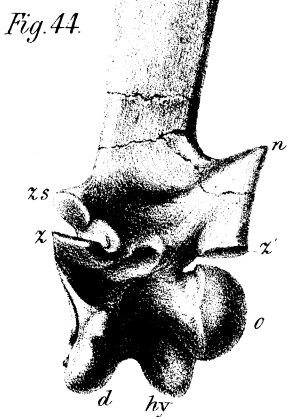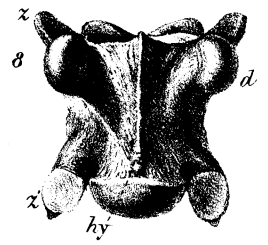
Palæophis

Fig. 48.

Fig. 53.

Fig. 49.

D.1.

Fig. 52.

Fig. 50.

D.2.

Fig. 54.

Fig. 51.

D.
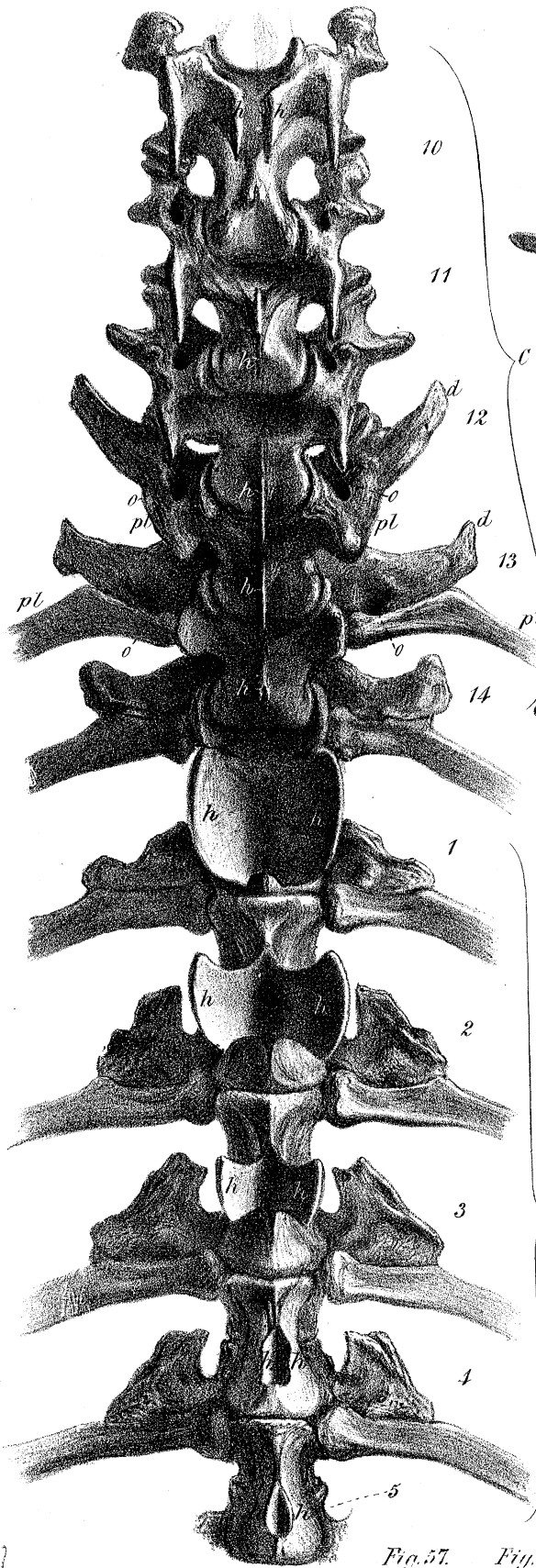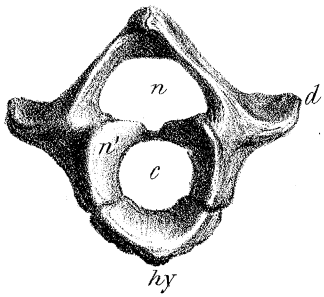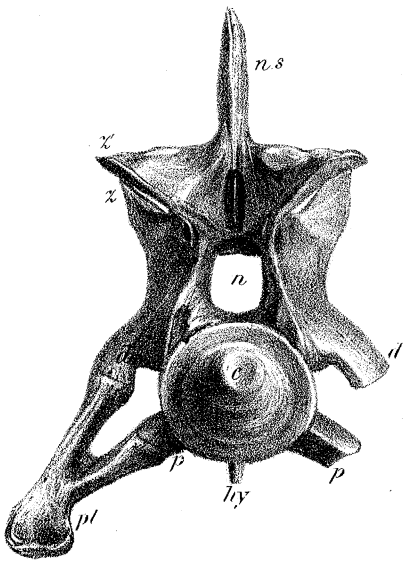
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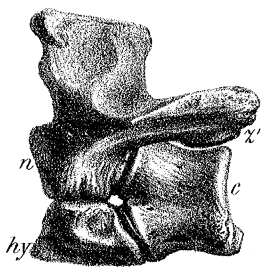
Fig. 55.

Fig. 56.
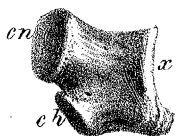
Fig. 57.

Fig. 58.
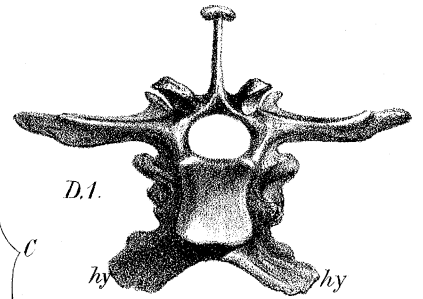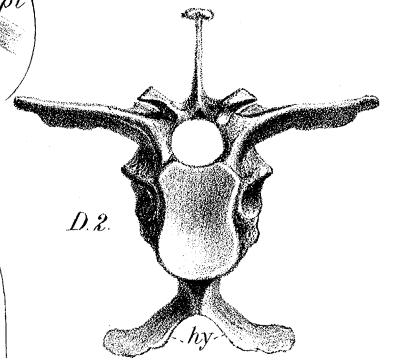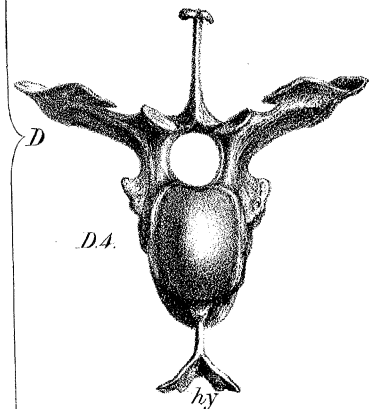
Fig. 59.

Aptenodytus Patagonica

Fig. 18. The eleven dorsal vertebræ and four of the lumbar vertebræ of the long-tailed Armadillo (*Dasypus longicaudus*), from the dorsal aspect, showing the abrupt commencement and great development of the metapophyses, *m*.

Fig. 19. The twelve dorsal vertebræ and three lumbar vertebræ of the Three-banded Armadillo (*Dasypus tricinctus*) ; a side view, showing the successive super-addition to the diapophyses (*d*), of metapophyses (*m*), anapophyses (*a*) and parapophyses (*p*) ; and the progressive development of the anapophyses and metapophyses.

Fig. 20. The last five dorsal and first three lumbar vertebræ of the Great Ant-eater (*Myrmecophaga jubata*), showing the progressive development of the met-apophyses (*m*) and anapophyses (*a a'*), together with the diapophyses (*d*) and parapophyses (*p*). The pleurapophyses (*pl*) are left in outline. A side view.

PLATE L.

Fig. 21. Front and back views of the eleventh dorsal vertebra of the same Ant-eater, showing—

        p. The parapophysis ; *p a*, its articular surface.

        d. The diapophysis ; *d, pl*, its articular surface for the pleurapophysis.

        m. The metapophysis ; *m a*, its articular surface for the anapophysis.

        a. The anapophysis ; *a p*, its articular surface for the parapophysis ; *a m*, its articular surface for the metapophysis.

        z. The anterior zygapophyses, with articular surfaces looking upwards.

        z'. The posterior zygapophyses, with articular surfaces looking down-wards.

        pl. Head and tubercle of pleurapophysis.

Fig. 22. Front and back views of the last (15th) dorsal vertebræ ; which in addition to the parts specified above, shows—

        mz. The articular surface of the metapophysis for the modified or newly developed posterior zygapophysis (*z'*).

        zm. The articular surface of the posterior zygapophysis for the metapophysis.

        The ordinary zygapophyses are almost suppressed.

Fig. 23. Front and back views of the third lumbar vertebra, which besides the parts specified above, shows—

        da. The articular surface on the diapophysis for the anapophysis.

        ad. The articular surface on the anapophysis for the diapophysis.

PLATE LI.

Fig. 24. Side view of a middle trunk-vertebra of the *Python Sebæ*.

Fig. 25. Front view of ditto.

Fig. 26. Back view of a middle trunk-vertebra of the *Python Sebæ*.

Fig. 27. Under view of ditto.

Fig. 27'. Vertebral ribs or 'pleurapophyses' of the *Python*.

Fig. 28. Front view of a middle tail-vertebra of ditto.

Fig. 29. Side view of a middle trunk-vertebra of the *Coluber elaphus*.

Fig. 30. Front view of ditto, with one of the ribs.

Fig. 31. Back view of ditto.

Fig. 32. Under view of ditto.

Fig. 33. Side view of a middle trunk-vertebra of the *Hydrus bicolor*.

Fig. 34. Side view of a middle trunk-vertebra of *Naja*.

Fig. 35. Back view of ditto.

Fig. 36. Side view of two middle trunk-vertebræ of the *Crotalus durissus*.

Fig. 37. Back view of ditto.

Fig. 38. Front view of ditto.

Fig. 39. Under view of ditto.

Fig. 40. Side view of a middle trunk-vertebra of the *Iguana*.

Fig. 41. Front view of ditto.

Fig. 42. Back view of ditto.

Fig. 43. Under view of ditto.

Fig. 44. Side view of a middle trunk-vertebra of the *Palæophis typhæus*.

Fig. 45. Front view of ditto.

Fig. 46. Back view of ditto.

Fig. 47. Under view of ditto.

The same letters indicate the same parts in each figure :—

    c.   The centrum.

    d.   The diapophysis, its articular tubercle.

    d'. Its inferior production.

    d''. Its superior production.

    z.   The anterior zygapophysis.

    z'. The posterior zygapophysis.

    ns. The neural spine.

    n.   The neurapophysis, produced into an angle in *Palæophis*.

    pl. The pleurapophysis.

    zs. The zygosphene.

    za. The zygantrum.

    hy. The hypapophysis.

PLATE LII.

Fig. 48. The five last cervical and five first dorsal vertebræ of the Great Penguin (*Aptenodytes patachonica*): an under view, showing the great development and metamorphoses of the hypapophyses (*h*).

Fig. 49. A back view of the first dorsal vertebra, showing the diverging hypapophysial plates (*hy*, *hy*).

Fig. 50. A back view of the second dorsal vertebra, showing the common base of the diverging plates (*hy*, *hy*).

Fig. 51. A front view of the fourth dorsal vertebra, showing the elongated base of the bifurcating hypapophysis (*hy*). In this vertebra the anterior surface of the centrum is simply convex, the posterior surface concave.

Fig. 52. A back view of the third cervical vertebra of a Crocodile, showing the diapophysis (*d*) and the parapophysis (*p*), or the upper and lower transverse processes of the right side; and the same, on the left side, with the co-articulated 'pleurapophysis' (*pl*) or 'hatchet-bone.' *c* is the ball on the back part of the centrum; *n* the neural arch; *ns* the neural spine; *z* is the prozygapophysis; *z'* the zygapophysis; *hy* the hypapophysis.

Fig. 53. Front view of part of the atlas of a Soft-tortoise (*Trionyx Dumerili*, O.). *c* the vacant space left by the absent centrum; *hy* the hypapophysis or 'wedge-bone'; *n* the neural canal; *n'* the anterior articular surface of the neurapophysis; *d* the diapophysis.

Fig. 54. Side view of the atlas of the same *Trionyx*. *c* the centrum; *hy* hypapophysis; *n* neurapophysis, its anterior articular process or prozygapophysis; *z'* zygapophysis.

Fig. 55. Anterior view of the centrum of the atlas, showing *c* its articular surface for the hypapophysis; *c n* its articular surface for its neurapophyses, and for the basioccipital or centrum of the occipital vertebra.

Fig. 56. Side view of the same; *x* the concave articular surface for the centrum of the dentata.

Fig. 57. Front view of the atlas of the Long-necked Tortoise (*Hydraspis longicollis*, BELL).

Fig. 58. Side view of the same vertebra. The centrum *c* ('odontoid process' of Anthropotomy) has coalesced with its neural arch *n*, and the typical character of the atlas, as it is manifested in the class of fishes and in enaliosaurians, is resumed; *hy*, the hypapophysis ('body of the atlas' in Anthropotomy).

Fig. 59. The eighth cervical vertebra of the *Hydraspis longicollis*, which, like the first caudal vertebra of the Crocodiles[*], is biconvex; *c* the centrum; *z* the two prozygapophyses; *z'* the postzygapophysis; *d* the two diapophyses.

PLATE LIII.

Fig. 60. A front view of the first caudal vertebra of the Great Ant-eater (*Myrmecophaga jubata*).

    c. The centrum.

    n, n. The neurapophyses.

[*] Physiological Catalogue of the Museum of the Royal College of Surgeons, vol. i. (1833) p. 53, Prep. No. 250.

ns. The neural spine.

z. The prozygapophyses.

m. The metapophyses.

d. The diapophysial base of the 'transverse process.'

pl. The pleurapophysial apex of the 'transverse process.'

hy. The hypapophyses.

h. The hæmapophyses.

Fig. 61. A. An upper view of the seventh caudal vertebra of a Beaver (*Castor fiber*).

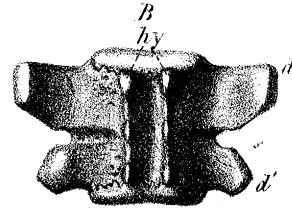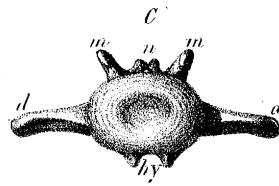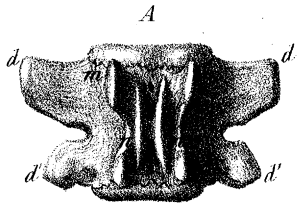B. An under view of ditto.

c. A front view of ditto.

Fig. 62. A. An upper view of the ninth caudal vertebra of the Great Kangaroo, *Macropus major*.

B. An under view of ditto.

c. A front view of ditto, wanting the terminal epiphysis.

In both specimens *n n* are the neurapophyses, which here become exogenous processes.

m m. The metapophyses.

d. The anterior diapophyses.

d'. The posterior diapophyses.

hy. The hypapophyses.

Figs. 63—66. These figures of the seventh and eighth cervical vertebræ of the *Trionyx Dumerili* have been inserted because the latter (fig. 66) combines two remarkable modifications which are separately presented by the occipital vertebra of the skull in the Frog, and in Man. In the Frog, as in all other batrachians, the occipital vertebra articulates with the succeeding vertebra, called 'atlas,' by a transverse pair of convex condyles, similar to those shown at *c c*, figs. 65 and 66: in the Human subject, as in all mammalia, the centrum of the occipital vertebra (*processus basilaris ossis occipitis*) is flattened and united to that of the atlas (*processus odontoïdes*) by a ligament: the back part of the centrum of the eighth cervical in the *Trionyx* (fig. 66, *c*) is, in like manner, reduced to a depressed plate, and is joined by a ligament to the succeeding centrum, viz. that of the first dorsal vertebra. The last cervical vertebra of the *Trionyx* resembles the first cervical in Man by having no neural spine: it is further remarkable for the peculiar development and form of its anterior (*z*) and posterior (*z'*) zygapophyses. Fig. 64 shows the two concavities at the back part of the centrum of the seventh cervical vertebra, which receive the two convexities at the fore-part of the eighth.

Fig. 61.

A

d d

m

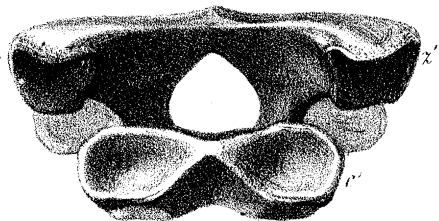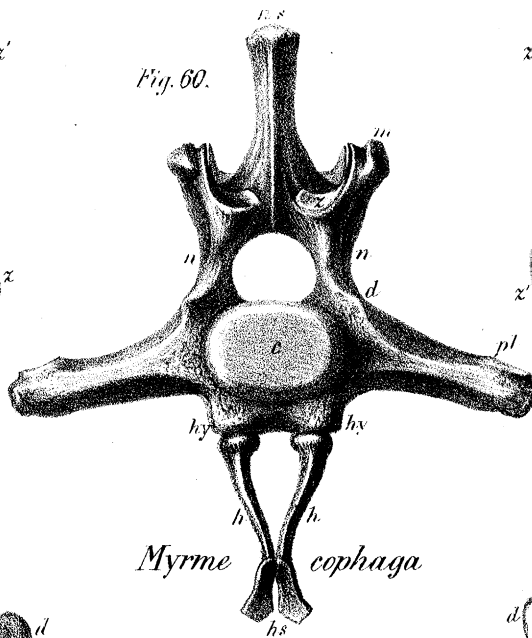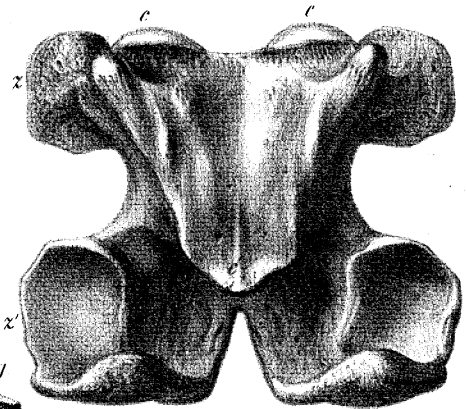d' d'

C

m n m

d' d

hy

B

hy

d

d'

Castor

Fig. 63

z'

c'

Fig. 65.

c c

z

z'

p'

Fig. 64

c'

z

c

Trionyx

Fig. 60.

n.s

m

m

n n

hy hy

c

d

h. h.

hs

Myrme *cophaga*

Fig. 62.

m r m

n

d d

d' d'

hy

Trionyx

A

d d

m m

n

d' d'

Upper.

B

d d

hy

d' d'
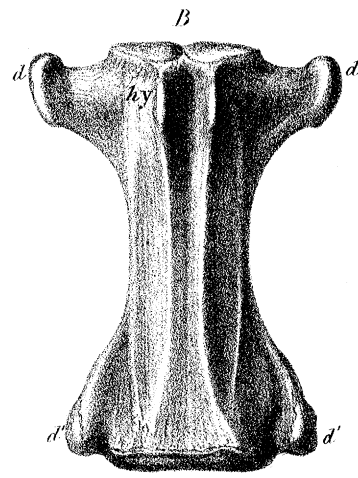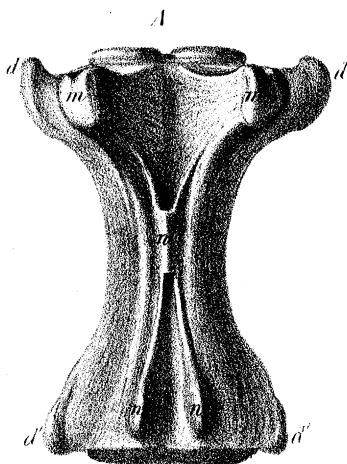
Under.

Macropus

9th *Caudal.*