THE OSTEOLOGY AND MYOLOGY OF DIDELPHYS VIRGINIANA.

By ELLIOTT COUES, A.M., M.D., Ph.D.,

ASSISTANT SURGEON, U. S. ARMY.

WITH AN APPENDIX ON THE BRAIN.

By JEFFRIES WYMAN, M.D.

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INTRODUCTORY.

Some account of the general traits of *Didelphys Virginiana,* its external form and covering, and dentition, may properly precede, and serve as an introduction to, the study of its bones and muscles. Among other articles upon its anatomy, physiology, and zoology, those cited below may be consulted.[1]

The present memoir is based upon original dissections and preparations, from which all the descriptions have been taken, except in a few instances where the contrary is stated; and all the illustrations were drawn by the writer from the same sources.

The opossum's form is adapted to the execution of numerous and varied movements, but not fitted for great strength, sustained effort, or rapid progression. The animal is sluggish, usually moving slowly and deliberately; its fastest pace is a kind of amble, when both legs of the same side are simultaneously moved, as is also the case when it is walking more slowly; it has not been observed to trot or lope. It is plantigrade, and the body is usually carried so low as to barely clear the ground. The body is thickset and clumsily shaped; the centre of motion is behind the middle, as shown by the general contour, as well as by the trend of the spines of the vertebræ. Extension of the body, as a whole, is less conspicuous than flexion, and is not ordinarily exhibited except when the animal is hanging suspended by the tail; but the body may be bent double, or rolled in a ball, with the greatest ease, the fore and hind feet passing by each other at the middle of the belly, and the nose pointing backward, reaching the root of the tail. The faculty of bringing the fore-paws and snout into such unusual positions is undoubtedly in subservience to the necessity of certain voluntary acts on the part of the female during and immediately after the act of parturition, such as the removal of the helpless fœtus to the pouch, and subsequent fostering of it. Great power of flexion is also essential to ready recovery of an ordinary position after suspension by the tail; as may easily be shown by holding up one of these animals in this position, when it will be observed to bend the neck and shoulders strongly forward, reach upward with its fore-paws until it can catch

[1] Owen. Article Marsupialia: Cyclopedia of Anatomy and Physiology, III. (1841.)

Meigs. American Philosophical Society. April, 1847. (Reproduction.)

Bachman. Proceedings Academy Natural Sciences, Philadelphia, pp. 40, 46. April, 1848. (Reproduction.)

Audubon and Bachman. Viviparous Quadrupeds of North America, II, 107, pl. 66. 1851. (Description and Natural History.)

Baird. Mammals of North America, 232. 1857. (Description, etc. See other authors there quoted, for Zoology, etc.)

Owen. Anatomy and Physiology of Vertebrates, II, and III, *passim.* (1866-68.)

hold of the loosely hanging hind feet; further action of all four extremities carries the paws to the root of the tail, which is firmly grasped, when the animal climbs up its tail "hand over hand" until the point of support is laid hold of; after which, by a peculiar squirming motion of the whole body, the desired attitude is attained. The same power of flexion is brought largely into play in most scansorial movements. Lateral motion of the body is also unusually free. The neck is short and thick; its motion is chiefly that of flexion. The head is of moderate size, appearing in life scarcely separated from the body, regularly cone-shaped, with little, if any, constriction at base, tapering gradually to a slender, elongated muzzle. The nostrils open at the sides of the extremity of the truncated, hog-like snout; the animal is reputed to have excellent olfactory powers, and the supposition is borne out by the large nasal chambers and sense capsules. The eyes, placed far up on the sides of the head, are small, with rather poorly developed lids; presumably in relation to eminently nocturnal habits. The external ears are extremely large, rounded, thin and membraneous, mostly naked, suggesting those of certain cheiroptera; the sense of hearing must be judged acute, if characters of the pinna afford a criterion. The rictus is long and ample; the lips thin and scanty; the large and numerous teeth are a conspicuous feature; the upper canines protrude beyond the lip, and lie outside the lower lip when the mouth is closed.

The opossum is pedimanous; as truly four-handed, perhaps, as many, or any of the quadrumana. The well-developed clavicles of the fore-limb, and the free coxo-femoral articulation of the hind one, permit both extremities to be widely separated, each from its fellow, and render easy the "hugging" movements necessary in climbing. Pronation and supination of the forearm are perfect; the wrist joint, besides revolving freely upon the ulna, is capable of great extension and flexion; of abduction and adduction in less degree. The fingers have much the same relative lengths as those of the human hand; but there is less difference between them, the little finger especially being comparatively longer and stouter, and the thumb longer, less divaricating from the axis of the other digits, and less freely opposable. This condition of the thumb results mainly from the more nearly perfect parallelism and closer union of its metacarpal bone; still it is "opposable," in the proper sense, and may easily be brought in contact with the tip of any finger, or of all together. The five anterior digits are unguiculate; the claws are non-retractile, and therefore stout, short, blunt and only moderately curved. The member, as a whole, is to be reckoned among the more perfect hands afforded by animals lower than man. Its ambulatorial function is secondary in importance; it finds its highest and proper use in climbing, in gathering food, and conveying it to the mouth; and in conjugal and maternal offices. The foot is nearly as much of a "hand" as the hand itself; it is equally fitted for grasping. The hallux, compared with the thumb, is even shorter, and more inclined from the axis of the other digits, to which it is freely opposable. It bears no claw; it is club-shaped, with a rounded extremity; in place of the claw there is a well-marked semilunar groove. The other toes are unguiculate; the claws are like those of the fingers, but longer, slenderer and more curved; the first three toes are of nearly equal lengths, and united by continuous integument beyond the first joints; the little toe is much shorter, but relatively, if not absolutely, stouter than the rest. The general shape of the foot recalls the quadrumanous type. The movements at the ankle are remarkably free, and seem to be more than simply analogous to those of the wrist. As to flexion and extension, the plane of the sole may sweep through an arc of more than 180°, moving from beyond a perpendicular to the axis of the leg, to beyond a parallel with the latter. The other movements of the foot, by whatever name they may be designated, amount to this: that the sole may present perpendicularly inward or outward, as well as horizontally downward, by extent of adduction and abduction; and the toes may point either inward, forward, outward, or directly backward, by extreme rotation. The first two sets of motions result from the ankle joint alone, but the whole limb is concerned in rotation.

The prehensile tail supplies a "fifth hand." This member is from two-thirds to three-fourths as long as the head and body together; thick and stout at the base, where there is no very evident point of distinction from the body; regularly and very gradually tapering to an obtuse tip; nearly circular on a cross-section, but somewhat flattened underneath, as if by constant pressure. The vertebral articulations and the muscles are so determined that the tail cannot be bent or curled upward, except near its base, where, also, lateral flexion is most marked; when not in use the tail is habitually carried with the tip curled under, so that it resembles a note of interrogation laid sideways ?. It has also a peculiar power of being twisted upon its axis, particularly toward the extremity, and so winding like a cork-screw around slender supports. The prehensile power is so great that the animal can suspend itself with only an inch or so of the tip of the tail hooked over a branch. Notwithstanding the general similarity of the long naked tail to that of a rat, it does not appear to have by its weight any special function of balancing the body when the animal is moving over uneven surfaces, as a rat's tail is supposed to have; its use is strictly limited to prehension; it chiefly comes into play when the animal is climbing, and more particularly assists it in gathering fruit from the extremity of the branches. The young attach themselves to the parent's body by the same means.

Most parts of the body are covered with two kinds of fur. The general covering is a kind of true wool, very fine, short, densely packed, of "kinky" fibre, imbricated and furrowed (scaly-imbricate), and with little or no pigmentary matter. Interspersed through this fur on most parts of the body are numerous true hairs, much longer, straight, stiffish, smooth and cylindrical, uncolored at the base, but loaded with coloring matter on the terminal third or half. These hairs are most numerous above, on the sides, and about the root of the tail; but they are nowhere thick enough to hide the true fur. Below, and on the insides of the limbs the fur alone exists. The hair almost fails on the terminal third of the head; the extremity of the snout is naked. The fur extends for two inches or more on the tail; the hairs project a little further. On the extremities the fur stops at the bases of the fingers and toes, and sides of the soles and palms; but the digits are sparsely hairy. A very fine, soft, short fur clothes the scrotum and lines the marsupium. The whisker-hairs are stout, stiff, straight and very long, but not numerous.

A few colorless, bristle-like hairs sparsely cover the backs of the fingers and toes, which are otherwise naked, as are the palms and soles, where the integument is thickened and variously modified, forming callosities, etc., or changing into horny plates. (Fig. 1, *a*, anconal, and *b*, palmar, aspect of hand: fig. 2, *a*, rotular, and *b*, plantar, surface of foot; nat. size.) Above, the digits are covered with somewhat irregular transverse scutella, scarcely overlapping, each divided once or twice across. The palms and soles are studded with small, round, convex tubercles; and the former have six, and the latter five, prominent callous pads, arranged and shaped as in the accompanying figures. The fingers and toes have on their under surfaces similar but better developed tubercles, to the tips, which are enlarged and rounded, and, like the pads, are not tuberculate, but present fine, curved ridges and depressions of cuticle, like the tips of the human fingers. These roughened and scabrous surfaces have evidently direct relation to the scansorial nature

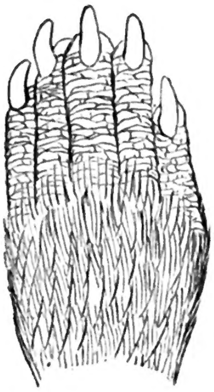


Fig. 1, *a.*

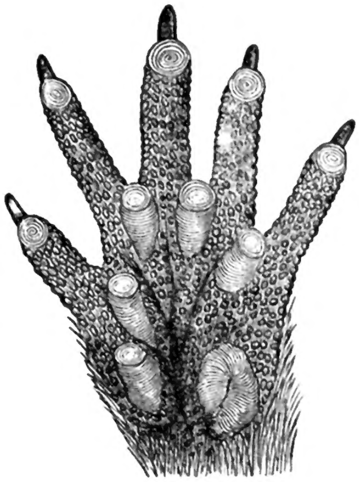


Fig. 1, *b.*

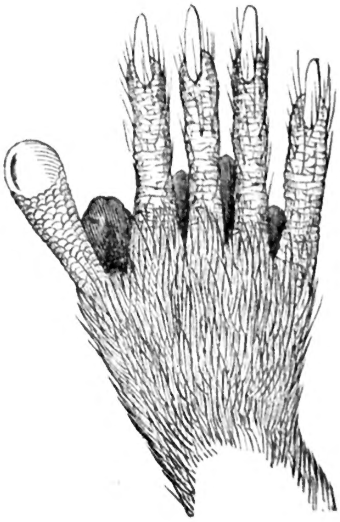


Fig. 2, *a.*

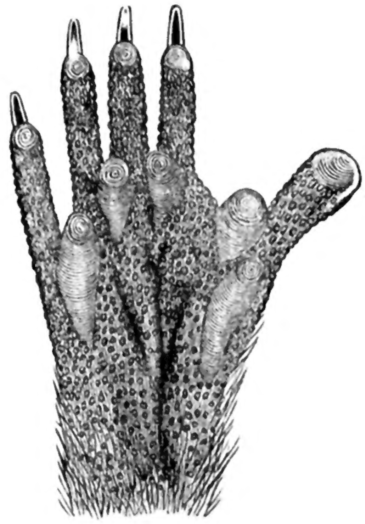


Fig. 2, *b.*

of the animal; and corresponding modifications occur in the integument of the tail, which assumes an almost corneous condition by thickening and hardening of the epiderm. As far as the hair extends, the skin of the tail is simply tough and dense; beyond this, the outer covering becomes harder and divided into small plates. These are oval or subcircular, or somewhat polygonal, from mutual apposition. Pigment granules appear in irregular blotches near the base; the tail is otherwise colorless. A few short, bristly, colorless hairs, like those upon the digits, lying closely appressed, are sparsely scattered over the whole tail. At any given point the scales are largest and flattest above, smallest and most tuberculate underneath; their average size diminishes regularly, with the tapering of the tail; they are regularly disposed in oblique rows, like the dorsal scales of serpents; there are about thirty in a circumference; the obliquity is slight, a row making an advance of about four scales' length in each half turn. The reticulation is somewhat imperfectly represented in fig. 3, which shows the side of the tail, of natural size, at junction of first and second thirds.

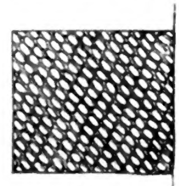


Fig. 3.


Fig. 4.

Short fur ascends a little way on the back of the ear, but disappears below the meatus in front. Most of the ear is flat and "foliaceous"; but toward the base it is much vaulted. The very thin lobule is of moderate size, full and rounded. The posterior margin of the pinna nearly reaches the root of the lobule, and forms a flap on the inner aspect of the latter. A crescent-formed protuberance lies just outside the termination of the anterior margin of the conch, which latter is lost in a transverse fold of integument that forms the anterior or external wall of the meatus, running across to meet a fold of the lobe itself. A triangular fossa is bounded by these two folds and the anterior margin of the ear. (Fig. 4.)

The ear and other naked parts of the body appear to have a low grade of organization, or at least less vitality than ordinary. Under unfavorable conditions, as when the animal is closely confined for a length of time, the ears, tail and digits are susceptible of ulceration, and often rapidly slough away. The Schneiderian membrane is peculiarly subject to hæmorrhage; epistaxis may be brought about, for example, by the passage of a current of electricity, or by very moderate violence.

The ano-genital orifice, as usually observed, has a puffy, inflated, almost prolapsed appearance, as if imperfectly guarded by the sphincter: the penis is almost always, however, withdrawn. The abdominal scrotum is loosely pendulous, almost pedicellate; its livid bluish color appears through the short fur. It is capable, however, of marked contraction; and the testicles may be closely drawn up. The pouch may be detected at a very early age; but in the virgin, though full grown, female, it is never conspicuous, and would escape observation unless sought for; it appears simply as a slight duplication of the skin, capable of admitting the tips of two or three fingers. It rapidly increases with use, and attains a large size, after which, though diminishing somewhat, it never returns to its original condition. The furry lining, at first colored like the rest of the belly, acquires during the pouch-gestation a fulvous or reddish hue; the nipples, at first small, concealed in folds of the skin that are scarcely perceptible, become very prominent, and are surrounded by a naked aureole. There are thirteen nipples, one central, the rest disposed in a circle. The lip of the pouch can be brought very near, if not in actual apposition with, the genital orifice. The transfer of the newly-born young to the pouch has been shown to be accomplished by the voluntary act of the parent, with lips or paws, probably the former.

The reproduction of the opossum, for a long time a subject of wild or fanciful speculation, has been satisfactorily determined by the researches of Dr. Bachman and others: to which, however, it would be out of place to more than allude in the present connection. The full history is given in the papers of this gentleman, already cited. Among the many curious beliefs that still pass current with the vulgar upon this subject, may be mentioned one that ascribes to the opossum, in consequence, doubtless, of the bifurcation of the penis, a coitus with the nostrils of the female; subsequent sneezing, on her part, upon the teats of the pouch causing the young to grow there.

The opossum is extremely tenacious of life. It is, in fact, rather difficult to kill one for dissection without mutilation of some part. In consequence of the shape of the parts, it is not easy to reach and pierce the medulla; a better way is to open the heart with a slender bistoury introduced between the ribs. I found poisoning with cyanide of potassium to be the most convenient method, with the additional advantage of affording a means of studying the operation of that very violent poison; but for rapid effect a larger quantity is required than would be expected to suffice; perhaps fifty times the amount that would almost instantly kill a pigeon. The most noticeable effects are at first profuse salivation, then unsteadiness of gait and general tremulousness, succeeded by clonic spasms alternating with perfect rigidity; ending with complete relaxation, accompanied by copious alvine and urinary evacuations. The time required is from five to fifteen minutes, according to the dose, and strength of the subject.

The natural history of this quadruped has been so fully elucidated by Audubon and Bachman, that little remains to be learned. It is strictly nocturnal, like many, if not most marsupials. The females, indeed, hardly leave their retreats at all during the two months of uterine and pouch gestation. As the teeth show, it is omnivorous; any quadrupeds or birds that it can overpower, eggs, reptiles, insects and worms, berries and fruits of all sorts, form its food; it will at times eat carrion, half a dozen individuals having been found at one time feeding on a dead cow. At certain seasons, especially in the fall, it acquires a deposit of fat, chiefly in the subcutaneous tissue, rivalling in amount that of a well-fed hog, and when in this condition its flesh is palatable. Particularly when thus fortified, it may fast a long time without inconvenience; and under ordinary circumstances can survive for three or four weeks without food or water. An individual upon which I was experimenting passed this length of time with no other food than its own tail, which it gnawed off and ate during the last few days before it was killed. According to Dr. Bachman it sometimes becomes quite tame; but all the individuals I kept in confinement remained to the last as sullen and ferocious as when first caught. It has no voice beyond a low growl, and a sort of hiss when provoked; under the influence of fear or anger a transparent viscid saliva drops constantly from the mouth. Its personal habits, in close confinement, are filthy; the odour, which under the most favorable circumstances is not agreeable, becomes very disgusting after a time. To a common observer it appears dull and uninteresting in confinement, passing the day huddled in a corner, and the hours of darkness in persistent endeavors to escape. It ordinarily, or at least for a long while after capture, refuses food by daylight, and resents too familiar approach by a sinister expression, and the display of a formidable set of teeth. If fortitude under physical pain, and acceptance of death without dismay, be tests of courage, the opossum is one of the bravest of beasts; no amount of torture can draw from it a sign of suffering. Such endurance, joined with remarkable cunning, enables the animal to feign death so perfectly that it frequently escapes, and not seldom retaliates upon its persecutors with an unexpected wound from its sharp teeth. These are well known traits, that have given to the English language a proverbial expression of peculiar significance.

THE TEETH.

Dental Formula: —Inc. $\frac{5-5}{4-4}$; can. $\frac{1-1}{1-1}$; prem. $\frac{3-3}{3-3}$; mol. $\frac{4-4}{4-4}$; $= \frac{26}{24} = 50$.

As the foregoing formula shows, four kinds of teeth are present, and indicate an omnivorous animal of carnivorous propensities. In number the lower teeth only differ from the upper in being one less on each side, by the absence of one pair of incisors. In size and shape, however, the upper and under teeth, especially the molars, differ considerably. The dentition apparently comes nearest to that of *Thylacinus cynocephalus*, among *Didelphia*, and thus resembles that of the *Canidæ*. (For general comparisons of the teeth with those of other marsupials, see Owen, Comp. Anat. and Phys. Vert., III, p. 285 *et seq.*)

Upper Jaw. The median pair of incisors are longer than the rest, and stand a little apart from the succeeding ones. The others are in close juxtaposition, though not usually in actual contact; and of the same size. All are simple, straight, short, somewhat compressed, with slightly enlarged head, not pointed or edged, but obliquely truncated, resulting in a flattened, cutting surface that looks forward and inward. The long axis of the tooth is almost vertical: the root is unicuspid and rather longer than the exposed portion. An average incisor, root and all, is a fourth of an inch long.

A considerable interval occurs between the incisors and the canine, for the reception of the lower canine. The upper canine is of remarkable size; this formidable weapon is as large, comparatively, as—even if it does not exceed—the tusk of the *Felidæ* or *Canidæ.* The whole tooth is over an inch in length, in an adult male; rather more than half its length protrudes from the socket. In the female, the tusk is both relatively and absolutely smaller. The large root causes a protuberance of the jaw-bone along its course; the base is abruptly truncate, with so large a cavity that the rim of the opening is a thin, sharp edge. The canine is compressed laterally and curves regularly from base to tip in the arc of a large circle; so, although the course of the root in the alveolus is obliquely forward, the point of the tooth is directed downward, and a little backward. In an unworn condition, the tooth tapers to an extremely sharp point, which reaches below the edge of the mandibular alveolus. The opossum's bite is severe, and inflicted mainly by the four canines, which the animal can easily thrust through stout boot-leather.

The first premolar is much smaller than the other two, from which it is separated by a wide interval. It is inserted immediately behind, in juxtaposition with, the canine, and almost appears like a basal snag of the latter. It has two very long, slender, parallel roots, curving slightly backward; these roots do not join to form the body of the tooth until fairly outside the socket; a slight groove is continued downward from their point of union. The exposed portion of the tooth is very small—scarcely half as long as the root; it tapers rapidly to a single sharp point, with no noticeable basal dilation. The second and third premolars successively enlarge; the exposed portion correspondingly preponderates over the rooted part; the latter is deeply cleft into two prongs as before, but these are stouter, straighter and divaricating a little from each other. These teeth are unicuspid, like the first premolar, but heavier, blunter, with a thicker base; and at the base of the posterior border a well developed snag is given off. The second premolar touches the third by means of this basal snag: the third is opposed to the first molar by the same means.

The first three molars are very similar to each other in essential characters, and increase in size from first to third; the fourth, or wisdom tooth, is smaller than either of the others, and differently shaped. It is cut later than the rest; I find it scarcely protruding from its socket in an animal two-thirds grown. The cutting of all the molars appears from before backward. The molars are in mutual contact by their external borders; the triangular shape of the crown produces a large interval between contiguous teeth along the inner border. The crown of the first three molars has the shape of a right-angled triangle, with nearly equal base and perpendicular. The anterior border proceeds straight inward toward the median line of the mouth; thence with a rounded termination obliquely backward and outward to meet the external border. Each of the three corners of the teeth developes a moderate cusp: the middle of each side rises into a smaller tubercle (that of the oblique side being the largest); the grinding surface surrounded by these elevations is irregularly concave. On viewing the molars from the outside, each appears almost divided into two by a deep notch in the lower border, which is opposite a similar notch in the upper border, formed by the late confluence of the fangs.

The molars have three roots, corresponding to the three corners of the crown; two of the roots are side by side, and external; the third stands alone; all are straight, slender and nearly parallel; each prong enters the alveolus by a distinct perforation of the bone. The last molar has three roots like the others, but these are differently disposed. The outer one stands alone, and is much larger than the other two, which are placed side by side, though they still enter the alveolus by separate apertures. The surface of the tooth, instead of being triangular, represents half an ellipse divided along its major axis; the curved border is posterior; the straight one is nearly transverse, like the corresponding anterior border of the preceding molars. The crown of this tooth presents an elevated rim and a central depression, divided into two halves by a raised line that traverses the short diameter. The inner and outer angles of the two parts have slightly developed cusps; the middle of the straight border rises in a small point. The surface represented by the conjoined crowns of all the molars is but little convex in the longitudinal direction; the point of greatest convexity is at the penultimate molar, whence the curve sweeps rapidly up past the last molar, and more gradually up along the anterior ones. The most prominent molar just reaches a line drawn from the tip of the canine to the apex of the paroccipital. The grinding surface of the last molar looks directly downward; that of the others is more and more obliquely bevelled from third to first, so that the grinding surface of the conjoined molars is twisted upon itself. The transverse diameter of the upper molars contrasts strongly with the narrowness of those of the lower jaw. (For upper teeth, see fig. 10 and fig. 11, p. 64.)

Lower Jaw. The four incisors on each side repeat the main characteristics of those of the upper jaw, but the median pair are not noticeably longer than the rest, nor do they stand apart from the others. These teeth are in close proximity to each other, but not touching. The chief peculiarity is their great forward and outward inclination; the anterior ones, in fact, are almost horizontal, instead of vertical. When the jaw is closed, the four teeth are opposed to the interspaces between the four lateral upper incisors, falling inside the line, and not reaching the median pair of the latter.

The lower canine is smaller than the upper, but still of great size. It is inserted in juxtaposition with the last incisor, and closes in front of, and inside of the upper canine, in the wide space that occurs between the latter and the upper incisors. Its root is longer than the exposed portion, much flattened, and inserted very obliquely in the bone. The free portion is stout at the base, rapidly tapering to a sharp point, and much curved, to bring the tooth into the vertical position from its very oblique line of insertion. As a whole, the tooth is notably twisted upon its axis. It measures, in adult examples, nearly an inch in length.

The first premolar is situated midway in the wide interval between the canine and the second premolar. This brings it directly under the upper first premolar, and leaves room for the apex of the upper canine to descend between it and the lower canine. This tooth repeats the characters of the corresponding upper one, but is still smaller. The second is much the largest of the under premolars, but scarcely differs otherwise from the third, with which it is in contact by a largely developed basal snag on the posterior border; a similar snag upon the third connects the latter with the first molar. These teeth close in advance of the corresponding upper ones; so that the second premolar passes by its posterior border along the anterior border of the second upper one; the latter is wedged between the second and third under premolars, its apex resting upon the basal snag of the former; the third under premolar is similarly wedged between the second and third upper ones; the latter, again, fits in the interspace between the third under premolar and first molar, with its apex touching the basal snag of the former. Each of the premolars has two long, stout, straight roots, parallel with each other; they cause a deep sulcus to appear on both inner and outer aspects of the exposed portion of the tooth, before uniting to form the single, compressed, conical cusp. The anterior border is a little convex; the posterior twice concave, as a result of the projection of the basal snag.

The four molars are remarkable for possessing but two roots apiece, like the premolars, instead of three as those of the upper jaw have. In the formation of the crowns, however, the transition from the premolars is abrupt and decided. The roots are straight, slender, terete, tapering, diverging but little from each other, following each other in the line of the axis of the jaw-bone, and are two or three times as long as the exposed portion of the tooth. The contour of the crown corresponds to the absence of a third (inner) root; it is a narrow rectangle, without angular extension inward. While quite as long as the upper ones, each for each, the lower molars have not half the breadth of the latter; when the two sets are apposed in the closed jaw, a considerable part of the grinding surface of the upper molar lies external to the under series. The molars progressively increase in length, width, heighth and prominence of the several irregularities of surface, from first to fourth. The antero-external corner of each presents a concave depression for the reception of the cusp upon the posterior border of the corresponding upper tooth; a larger excavation upon the face of the crown, at its back part, similarly receives the prominent inner corner of an upper molar. Between these two depressions the outer border of each molar rises to form a prominent conical cusp, attaining the greatest elevation on the last of the series. Behind the cusp is a smaller one, at the postero-external angle of the tooth; the postero-internal corner makes a still less prominent cusp. The antero-internal angle rises highest of any; its strong cusp is partially divided in two by a notch. (For under teeth see figs. 7 and 8, page 62.)

The upper molars have much more of the character of true "grinders" than the lower; the latter are evidently better fitted for the laceration of animal tissue than for the crushing of vegetable fibre. The crowns of the upper molars chiefly present obtuse rounded inequalities of surface; those of the lower show conical sharp-pointed projections.

The whole series of lower teeth is twisted upon itself, and traverses the jaw obliquely, as shown in fig. 8.

PART I. — THE BONES.

1. The Skull.

The cranium is to be considered under three different aspects. First, as being a phase of the mammalian modification of what has been called the vertebrate archetype; representing, as such, four vertebræ, the elements of which have been subjected to changes of relative size and shape, and also, in many instances, to dismemberment or displacement, and the essential characters of which have been further modified — not to say obscured — by the addition or intercalation of accessory and appendiculate parts, as well as by the suppression, or at least the want of distinctness, of certain parts found in those crania that depart less from the primitive type. Secondly, as being composed of numerous individual parts or pieces; that is, of separate bones, suturally joined with contiguous ones, but not continuous through coössification; such parts expressing not only the division of the skull into four vertebral segments, but also the distinction of the several elements of each segment, and of its appendages. Thirdly, as a complex whole, resulting from the coherence or confluence of all these several proximate and ultimate parts; as such forming a bony box to contain and protect the brain and organs of the special senses. From the first view may be learned the ultimate, or true, or *de jure* morphology of the skull; from the second, its proximate or apparent, or *de facto* morphology; from the third, its teleology, which is the aim and end of all morphology. The cranium, *quoad* four vertebræ, represents or typifies the skull of all vertebrates; as to its individual bones, the skull of all mammals; as a whole, only itself — so far is general morphology modifiable for special teleology.

No two leaves of the forest are precisely alike; no opossum's skull is an exact duplicate of another's. One skull may be so described that the description will not apply to any other one; or in such a way that the terms employed will indicate the skull of any vertebrate; and each of the two methods are perfectly truthful. An account of individual peculiarities only would be tediously profitless; a summary of class, ordinal, or family points alone, would leave much to be desired; a description of specific characters is alone satisfactory, for these mark one entity amidst innumerable forms of animal life. Specific description of a skull may be more general or special, according as more or fewer relations are considered. In a general way, the relations of the opossum's skull to the crania of other vertebrates may be indicated in a description of its four vertebræ; to that of other mammals, in a notice of its different bones; and to that of other marsupials, in its consideration as a whole. It suits my purpose to take up these three lines of description, and in the order just indicated.

a. Of the skull as four vertebræ (*diarthromeres*[1]).

V. epencephalica.—The hæmal arch rests upon the thorax; the centrum and neural arch can usually be detached entire from the antecedent vertebra, without disturbing the latter. The only element that ever coössifies with the antecedent segment is the neural spine, and this confluence only takes place in aged skulls. The neural spine is rarely consolidated with the neurapophyses; the latter, though meeting above the foramen magnum to complete the neural canal without the intervention of the neural spine, remain distinct from each other, but early unite with the centrum. The parapophyses even sooner unite with the neurapophyses; coössification is completed in specimens that still show traces of separation between neurapophyses and centrum. In physical characters, the occipital

[1] "*Diarthromere.*— A word needed to supplant 'vertebra,' in the sense attached to this last in this paper. 'Vertebrate' may be sufficiently definitive of a back-boned animal, but 'vertebra,' at best a meaningless name of certain 'bones,' is inadequate to express the required idea of a whole segment of an animal constructed upon the double-ring plan, besides being so firmly contracted by custom that the necessary expansion is undesirable, if not impracticable. The typical segment—zoönule, or somite—of single-ring animals (Articulates) is already called *arthromere*, of which the proposed word is an obvious analogue.'"—*New York Medical Record, Dec., 1870.*

Although we should of course prefer to employ this term, which we recently proposed, as above, yet it is now practically impossible to revise the MS. for this purpose.

segment, as a whole, is not more unlike the succeeding one — the atlas — than the latter is unlike the axis; or than this last is different from a coccygeal, for instance.

Aside from the displacement of its hæmal arch, its chief modifications relate to its firm sutural (instead of loose articular) connection with the antecedent vertebra, and to the expansion of its neural arch to accommodate the epencephalon. Taking away the expanded neural spine, the three remaining elements form an osseous ring very similar in general appearance to the atlas. It does not appear that the sum total of the modifications that this vertebra has undergone in becoming a part of the "skull" instead of the "spine," is greater than that suffered by the contiguous cervical one, which latter is none the less a "vertebra" for wanting centrum, neural spine and hæmal arch; and it is certainly less than that characterizing the last coccygeal,— a bone that has nothing of a vertebra but a degenerate centrum, fails to perform the essential office of a vertebra, and is only recognized as a vertebra in virtue of its location, being to all purposes, as well as appearances, the distal phalanx of a digit. Comparison of the two ends of the chain of vertebral links shows that teleological modification is less obscure in the guise of hypertrophy, than under the mask of atrophy; exaltation of the function of parts may entail less change than degradation; the caudal larval vertebra deviates more from the archetype than the cranial imago does.

V. mesencephalica. Centrum and neurapophyses coalesce with the same elements of the antecedent (frontal) segment; the compound bone so formed ("sphenoid") is simpler than in some mammals, from not including an appendage of the maxillary arch; for the pterygoid is a distinct bone, as in birds. The neural spine is large, coincidently with increase in size of the encephalon, though it is itself surpassed by the frontal spine. It is developed from two centres, and the lateral moieties so long remain discrete, that they are so found in the great majority of adult specimens; but they ultimately fuse together; they never coössify with either frontal, squamosal, or sphenoid; they reach their proper neurapophyses. The parietal parapophyses (mastoid) are disconnected with that arch, coössified with the acoustic capsule, and wedged in between the latter, the occipital neur- and par-apophyses and the distal element of the appendage of the palato-maxillary arch, which appendage serves as a strong osseous bridge connecting the hæmapophysis of the nasal vertebra with the par- neur-apophysis of the ultimate and penultimate cranial segments, and slightly joins, also, the neural spine of the occipital segment. Besides the extensive confluences and sutures that the parietal segment presents, it also contains — *i. e.*, is the site of — the frontal pleurapophysis, — the proximal element of the mandibular arch (tympanic). This, however, has no osseous connection with the rest of the skull; its relation to the parietal segment is merely one of position. The proper pleurapophysis of the parietal segment (stylo-hyal) is wanting; the other elements of the hyoidean arch[1]

[1] The os hyoides may be conveniently noticed in this connection. The size and general shape are shown in the accompanying figure (fig. 5). The five pieces comprising the hyoid are usually (always?) distinct: I have never seen them anchylosed. The thyro-hyals are elongate, much compressed in an oblique plane, enlarged at either extremity, slightly curved in the continuity. The cerato-hyals are small, flat, triangular nodules remaining cartilaginous for a considerable time. They are mostly supported upon the basi-hyal, but also touch the thyro-hyals. The basi-hyal is small; as high as wide; irregularly five-sided, or rather sub-quadrate, with a thickened, upright, posterior, lower border between the ends of the greater cornua, spreading obliquely upward and forward into a thin lamina with slightly thickened sides, supporting the lesser cornua, and having its sharp, free anterior border somewhat produced by cartilage. There is no uro- or glosso-hyal; no lytta could be found in the substance of the tongue. The cerato-hyals do not appear to have ever formed two pieces.

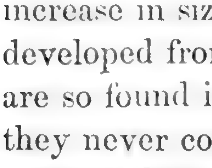


Fig. 5.

are only connected with the skull by soft tissues, and are removed from its immediate vicinity; the styliform occipital parapophyses appear to perform, as far as muscular attachments are concerned, the office of the hyoidean pleurapophyses.

V. prosencephalica. The confluence of the frontal centrum and neurapophyses with those of the parietal segment, has just been noticed; these elements are distinct from their homotypes of the nasal vertebra. The neural spine, at first in lateral halves, speedily consolidates into one piece, but coössifies with none of the numerous surrounding parts. It is remarkable for its size, and for taking greater part in the formation of the olfactory chamber, than in the protection of the prosencephalon. Frontal parapophyses are wanting; at least no post-frontals can be demonstrated, nor is there evidence warranting the assumption that they are included, otherwise than theoretically in the frontal, or a neighboring, bone. It may however, be surmised, that the super-orbital protuberances of the frontal bone may represent, teleologically at least, such parapophyses; since they subserve the usual function of limiting the orbits posteriorly. The pleurapophysis is disconnected with the other elements of this vertebra, dislocated, lying between the last and the penultimate vertebræ, and pressed into the service of the organ of hearing; it is a delicate little half-ring, supporting the membrana tympani and ossicula auditûs. As already noted, it has no osseous union with the rest of the skull; and even its membranous attachments are of the loosest nature. No trace of separation of hæmapophysis from hæmal spine is usually to be observed; nor is there any distinction of the several hæmapophysial elements that remain distinct in lower classes, and may theoretically be taken to exist in the present example. The hæmal spine is permanently separated into halves, as far as osseous symphyseal union is concerned. The frontal hæmapophysis not only articulates with the distal element of the maxillary appendage, as usual in mammalia, but also with the proximal element of the same; and moreover—what is a rare modification — with the parietal neurapophysis, (squamosal, malar and alisphenoid thus conniving to form the glenoid cavity); it is not connected with its own, or other pleurapophysis.

V. rhinencephalica. The centrum, permanently distinct from that of the succeeding vertebra, is an attenuated osseous spiculum, only having solidity behind for articulation with the presphenoid; it is in intimate relation throughout with the enormously developed olfactory sense-capsule. The neurapophysis, if it have any actual existence, is obscure, and not to be satisfactorily demonstrated in any part of the olfactory capsule; but it may be conjectured that the vertical "septum nasi" represents coalesced pre-frontals. The neural spine is permanently bifid, and remains distinct from surrounding bones; like its centrum, it has been subjected to longitudinal extension and attenuation, to close in the upper wall of the conical muzzle. This vertebra has no diapophysis. The pleurapophysis forms but little part of the maxillary arch, though still performing its proper office much more notably than does the same element of the frontal vertebra. As usual, it is curiously distorted in shape, and closely wedged in between numerous elements not of its own, but of two succeeding, vertebræ. The development of the nasal hæmapophysis corresponds with that of the frontal; it articulates not only with its fellow, its pleurapophysis, and its hæmal spine, but also with the neural spines of its own and of the succeeding vertebra; it likewise supports, in part, a mucous scale-bone and convolutions of a sense-capsule; and besides is connected, through the intermedium of two accessory appendicular pieces, with the neur- and par-apophysis and neural spine of the parietal, and neural spine of the occipital, vertebra. So the nasal hæmapophysis connects mediately or immediately, its own with each of the three other cranial vertebræ; such extensive connections not only contribute to the strength and fixity of the palato-maxillary arch itself, but of the whole skull. The hæmal spine is permanently double; it maintains distinctness from the hæmapophysis; above, the apex of the neural spine is wedged in between its lateral moieties; below and anteriorly, these are in mutual apposition, thus closing in the termination of the neural canal. The "diverging appendage" of the palato-maxillary arch (pterygoid), a delicate scale-like bone, loosely attached, extends backward under the centra of the frontal and parietal arches; it falls far short of the frontal pleurapophysis, instead of connecting the latter with the nasal pleurapophysis, as in birds; nor is it subservient in any way to either the stability or the mobility of cranial segments. The orbital dermo-skeletal, and the acoustic and olfactory splancho-skeletal, bones are elsewhere noticed: the opthalmic sense-capsule is unossified.

b. Of the Several Cranial Bones.

Most of the cranial bones of this low mammal retain their individuality; a few others only coössify with age; several are confluent from an early period of their formation, if not originally connate. The skull is readily disarticulated, and reducible to a greater number of pieces than is the case with higher mammals. Nearly all the bones afford instructive evidence of their morphological characters. The comparatively few compound bones result from confluence of but few morphologically distinct elements: there is no such complex "bone" as, *e. g.*, the "sphenoid" or "temporal" of anthropotomy. The mammalian modification of cranial vertebræ may therefore be studied under advantageous circumstances.

The skull ordinarily falls into the following pieces, some of which are simple, and others compound, bones; the latter are in italics:—*occipital*; superoccipital; *two petromastoids*; parietal, either single or double; tympanic (with ossicula auditûs attached); *sphenoid*; *vomer with ethmo-turbinal*; frontal, single or double; two nasals; two premaxillaries; two maxillaries; two palatals; two pterygoids; two malars; two squamosals; two lachrymals; and the *mandible* (qu. italics), in halves. Sometimes the great sagittal crest comes off the parietals, having only sutural union, and being apparently developed in the fascia between the temporales. The superoccipital may unite with the parietals in old age. The interparietal suture is often obliterated; the interfrontal usually. There are no pre- or post-frontals, nor stylo-hyals; unless the vertical plate of the ethmoid represents the first named. I have not observed an interparietal, or Wormian bones. Ordinarily there is nothing to indicate that the mandible is formed of articular, angular, splenial, coronal, and dentary pieces; but its symphysis is imperfect, being only a synchondrosis, like the pubic and sacro-iliac.

The following are the commonly observed confluences of originally distinct bones:—Ex- and par- with basi-occipital, producing an "os occipitis" the spine of which remains separate; its neurapophyses meet above the foramen, but do not ordinarily coalesce. Basi-, ali-, pre- and orbito-sphenoid, resulting in an "os sphenoidale" which is not further complicated by coössification with the pterygoids. Mastoid with the otic sense-capsule (petrosal) forming the "petromastoid"; the separation of these elements from the squamosal and tympanic, and the absence of a stylo-hyal, reduces the ordinarily complex "os temporis" to almost its simplest expression. Vomer with the olfactory sense-capsule (ethmo-turbinal); but the coösification is not perfect throughout. A spongy bone ("inferior turbinal") is attached to the inner surface of each maxilla.

The special characters of each of the bones above mentioned are now to be examined.

The *basioccipital* is only seen as a distinct bone in very young animals, although traces of separation from the neurapophyses persist during adolescence. Thus I find the suture, in an animal three-fourths grown, extending from the side obliquely inward and backward to the condyles, and exhibiting the part taken by the bone in the formation of the latter (about one third). The precondylar foramen is developed in, or just to, one side of this suture; another smaller opening exists a little internal to the last. The connection of the bone with the petrosal is slight; the most marked portion of the foramen lacerum posterius is just in front of the paroccipital. The forward extension of bone is simply a flattened plate, nearly four-sided, but tapering a little, abutting by a straight, transverse suture against the body of the sphenoid; longitudinally ridged underneath, smooth and slightly concave above, with an oblique groove alongside each anterior corner.

The *exoccipitals* rise from the back part of the body, develop the superior two-thirds of the condyles, and close over the foramen magnum, where, however, they do not ordinarily coalesce; the line of separation remained in all the skulls examined. They form a broad arch, whose longitudinal expansion is oblique, perforated on either side, at the base of the paroccipitals, and notched in the middle of the upper border for a descending process of the superoccipital; sometimes the upper border has a well marked prominence indicating the point where the superoccipital and mastoid come together.

I have never found the *paroccipitals* distinct from the exoccipitals. They form pointed conical processes of moderate length, directed downward, almost parallel with each other, roughened for muscular attachment. Their bases abut against the petromastoids; a deep notch separates them from the condyles.

The *superoccipital* is rarely, if ever, confluent with the exoccipitals. I have never seen it thus united. On the other hand, its bony union with the parietals is frequent, and with the "temporal bone," at the junction of the mastoid and squamosal, is sometimes seen. The lambdoidal suture, when not obliterated, is very irregular in direction, and mostly squamous in character, the outer surface of the superoccipital being bevelled for some distance. The superoccipital is a triangular pyramid, with an excavated base and sides: the concavity of the former being for the accommodation of the brain, and of the latter for muscular attachments. The excavations of the sides are virtually produced by the elevation of the occipital crest, which forms a segment of a circle from side to side; and by the beginning of the sagital crest, which runs directly forward from, and at right angles with, the middle of the transverse crest. The thickness and solidity of the bone, however, is not entirely owing to these crests.

Confluence of the *basi-*, *pre-*, *ali-* and *orbito-sphenoid* takes early place, and, when perfected, results in the single complex bone ordinarily called by the collective name "sphenoid." I find no traces of separation of these four bones in the youngest specimens examined. As might be expected from its composite nature, the connections of the bone are numerous. The contiguous bones are:—behind, the basisphenoid, and more laterally, the petrosal and squamosal (which separate it from the mastoid), and sometimes the malar: on either side, the parietal and frontal: before, the vomer, ethmo-turbinal, palatine, and pterygoid. There is no actual connection with the tympanic; the mastoid is still further removed. I have never found it confluent with either of these contiguous bones: its connection with the palatines is perhaps most intimate; with the pterygoids and petrosals loosest. Its frontal and squamosal sutures are the most extensive; but that with the parietal is of considerable length, since the squamosal does not lift the parietal far away from the sphenoidal ala—though it is difficult to say how much of the spheno-parietal suture is formed by the orbitosphenoid, and how much, if any, represents the union of the neural spine with its proper neurapophysis, the alisphenoid. The basisphenoid alone unites with the basioccipital: the alisphenoid alone with the petrosal and squamosal; the orbitosphenoid with the frontal. Junction with the palatines is through three of the elements of the sphenoid: the ali-, orbito- and pre-sphenoid; union with the former being effected by the "pterapophyses" to be presently noticed: the sphenoidal relations of the pterygoids are almost wholly brought about by the same means. The articulation of the sphenoid with the basioccipital and vomer respectively is simple abutment of the thickened, squarely truncated extremities of these bones; that of the palatines and pterygoids is the lateral apposition of elongated processes; that with squamosal, parietal and frontal is the true, squamous suture, most decided in the latter case, where the orbitosphenoid very extensively overlaps. When the alisphenoid reaches the malar at all, it is a simple touching of the tip of its slender, lateral, articular process. Junction with the petrosals is imperfect and irregular.

The compound "sphenoid bone," thus made up and related, presents a stout, flattened "body," tapering from behind forward, distinguishable from the "wings" by its shape and solidity, and separated from them by grooves, ridges and foramina, apparent both above and below. The under surface is smooth; on either side are seen, from behind forward, the termination of the foramen lacerum, medium: two foramina looking forward and outward, separated by a slight bony bridge, the posterior opening leading backward by a groove into the foramen lacerum, and forward into the sella turcica: the anterior, which is the larger, curving inward and communicating with its fellow below the sella: the groove separating the pterapophyses completes the lateral boundary of the body. Inside, the body presents a deep hemispherical or hemiellipsoidal excavation, the sella turcica, on either side of which (but really in the ala of the bone) is the entrance of the foramen rotundum, now a long canal, that opens just outside the root of the pterapophysis. More anteriorly the body is bounded on either side by a deep semicylindrical canal, which conducts the optic nerves out through the foramen lacerum anterius.

The alisphenoidal part of the bone stands away from the body, on nearly the same horizontal plane, having but little upward inclination; and supports three very noticeable processes. The most posterior of these is a moderately large bulla ossea, or conch, in subserviency to the acoustic organ. It is a hemiellipsoid in shape, its convexity looking forward and downward, its large opening directly towards the tympanum. It is small in size compared with that occurring in some marsupials. Besides its physiological relation to the organ of hearing, it serves to complete, internally, the irregular parapet surrounding the fossa in which the delicate tympanic hangs suspended: the other minarets being the paroccipital, mastoid and zygomatic process of the squamosal. The petrosal lies along its inner side; its outer side is in relation to the glenoid cavity and condyle of the jaw; at its inner base is a large foramen, sometimes, however, only a groove continuous with the foramen lacerum, from deficiency of the bony trabecule completing its periphery.

Perhaps the most interesting point connected with the sphenoid bone is the share it takes in the formation of the glenoid cavity, by means of a long, sharp-pointed "articular" process of the alisphenoid, which runs along the inner and anterior margin of the glenoid cavity, and usually reaches to the malar. This formation decidedly augments the transverse diameter of the glenoid, and a considerable part of the mandibular condyle plays upon the expanded and slightly concave under surface of the sphenoidal process. The latter, however, lying wholly in the general plane of the joint, does not afford an anterior wall of abutment for the condyle, like that furnished behind by the downward extension of the squamosal. The extent of the alisphenoid thus appropriated by the squamosal, perhaps explains why so much of the sphenoparietal suture is made by the orbital plate of the bone alone. This structure of the glenoid obtains in many, if not most, marsupials.

Anteriorly the sphenoid sends off on either side a long attenuated pterapophysis, which diverges from its fellow as it proceeds forward. These slender prongs reach as far forward as the termination of the bony palate; forming the main connection of the pterygoids with the sphenoid, augmenting the connections of the latter with the palatines, and forming part of the wall that laterally bounds the vestibule of the posterior nares.

Absence of a stylo-hyal, and non-confluence of the petromastoid, leave the "temporal bone" to be represented by the *squamosal* alone. There being but a small vacuity in the cranial wall to be filled by the squamosal, the greater part of this bone is devoted to the formation of the back part of the great zygoma, and the support of the mandible. The zygomatic process at first stands out at right angles with the squamous portion and then curves forward, expanded vertically, to effect extensive overlapping suture with the malar. The root of this process is thickened transversely for the site of the glenoid cavity; it sends downward a stout process to form the posterior wall of the articulation, and presents inwardly a rough, irregular projection for the alisphenoidal suture. The squamous part of the bone takes but small part in the formation of the wall of the encephalon, and less than appears upon viewing the skull outwardly, in consequence of the extent to which it overlaps the parietal. The posterior border of the squamosal is somewhat thickened and rises in a prominent ridge, which is the lateral downward continuation of the semicircular occipital crest. The termination of this crest represents the postero-lateral corner of the skull, in which the mastoid scarcely takes part, being small, and wedged in between the squamosal and the ex- and par-occipitals; separating the former from the last two. Above, the squamosal comes in direct relation with the super-occipital. A prominent ridge from the upper border of the zygomatic process connects the latter with the squamo-occipital crest, and overarches the otocrane. The fossa in which the parts of the ear lie is represented, in the lateral view, by a wide and deep notch between the glenoid process, and the termination of the occipital crest. Two large foramina are situated in the notched part of the squamosal. A well marked groove, extending along the inner aspect of the back part of the squamosal, is converted into a canal (venous) by a corresponding groove in the surface of the closely apposed petromastoid.

Confluence of the "mastoid process" with the otic sense-capsule results in the *petromastoid,* a small, hard, very irregularly shaped bone, firmly wedged in between the alisphenoid and basi-occipital before, the squamosal and ex-par-occipital behind, with an anterior prolongation that just touches the basisphenoid, dividing the fissuræ laceræ posteriores et mediæ from each other. It always remains distinct from the surrounding bones. When *in situ*, but little appears on an outside view; viewed from within, it is seen to take a large part in the wall of the brain-case, presenting a smooth, sub-triangular surface, indented with a very deep, conical, cerebellar fossa, below which is the conspicuous opening of the internal meatus. Most of the superficies presents a very irregular roughened surface, closely appressed to the thickened root of the squamosal, with a venous canal running across it. The part that lies external, between squamosal and occipital, is smoother, being only slightly roughened for muscular attachment. The petrosal part proper appears, viewed from below, as a small, tapering piece of bone, with a swollen base, this convexity expressing the dome of the "whispering gallery" into which the interior is sculptured. But the description of the internal structure of the bone rather pertains to an account of the organ of hearing, than to the subject of the present memoir, and must therefore be omitted.

The *tympanic* is a delicate little oval ring, incomplete at part of its circumference, like a horse shoe. It is not bullous, and has no bony attachment with the rest of the skull. It supports the auditory ossicles, one of which is anchylosed with it. There are no decided angles or processes; but a noticeable groove for the membrana tympani, and another representing the confluence of the ossicle; the latter adds considerably to the tympanic half-ring, strengthening the slender, spicula-like prong; it is applied to the outer periphery, terminating by a somewhat thickened, rounded extremity; at the free end bent abruptly upon itself, in the plane of the tympanum, and extending, as the handle of the malleus, almost across the space to the back of the ring, as an extremely delicate spicula.

The *parietals* finally coalesce with each other along the median line; but in most specimens the sagittal suture is retained. The contour of the bone is very irregular; all the sutures except the sagittal are strictly squamous. The anterior margin overlaps the frontal bone for a great distance; the posterior, the super-occipital, but to less extent; conversely, the lower border is overlapped by the sphenoidal ala and the squamosal. Viewing the articulated skull from the outside, the parietal seems only joined below by the orbito-sphenoidal and squamosal plates; but, on removal of the latter, the posterior portion of the margin is seen to effect junction with the alisphenoid itself. At least, such is my impression from consideration of the parts of the sphenoidal ala, most properly to be regarded as ali- and orbito-sphenoidal; for the spheno-parietal suture extends to the base of the sphenoidal process that enters into the mandibular articulation. The parietal bones are thin — almost diaphanous; internally they exhibit a decided hollowing, whose concavity is greater than the outside convexity of the bone; the meningeal vessels impress well marked grooves along the posterior border of the vitreous table; the falx cerebri a single longitudinal one along the median line. The inner table of the bone is of much less extent than the outer, in consequence of the various extensive squamous sutures of the latter: there is little diploë between the two; its texture is coarse, with large interstices. There were no inter-parietal bones, nor ossa Wormiana, in any of the specimens examined.

Even in young individuals, in which the sagittal suture is perfect, there exists only a trace of the frontal suture; and this is speedily obliterated. The confluent *frontals*, taken as one bone, present a remarkable shape. Only a small part is devoted to the protection of the brain; the rest forms the roof of the nasal, and the inner wall of the orbital, cavities. The point of greatest constriction of the brain-case is in the frontal bone, just in advance of the overlapping of the border of the parietal. The greatest width of the cranial part of the bone is much narrower than the nasal part; its depth is equally as much less. While the cranial cavity of the bone will barely admit the tip of one's forefinger, the nasal will contain nearly the whole of the first segment of the thumb; the former is nearly cylindrical; the latter represents the frustra of two cones placed end to end; the strait between the cranial and nasal cavities is perfectly circular. The coronal suture, never obliterated, may be either directly transverse, or obliquely placed, inclining forward from above downward; it has no notches, or other notable irregularities along its course. The coronal, and all the other sutures around the frontal are strictly squamous; the several bones (parietal, orbito-sphenoid, maxillary, palatal, lachrymal and nasal) all overlap the frontal, except for about half of the fronto-palatine suture, when the reverse takes place. The outer lower margins of the bone are very irregular in their course, but in general terms, may be said to be direct from the lower corner of the coronal suture through part of the palatal, and thence to extend obliquely upward and forward to the point of greatest anterior extension, between which point and its fellow there is a very deep notch for the reception of the nasals, usually extending quite to the supra-orbital protuberance. The anterior part of the surface of the frontal is perfectly smooth, and nearly flat in every direction; it is bounded in front by the naso-frontal, and at the side by the fronto-lachrymal, suture. Behind, it is separated from the orbital and temporal surfaces by two prominent ridges, which, arising from the supra-orbital prominence, rapidly approximate as they proceed backward, meeting each other on the median line, uniting, and running backward as the frontal portion of the sagittal crest. The part of the frontal forming the temporal fossæ is irregularly concave; the orbital part is smooth, plane, and vertical; the two are separated by a slight ridge running from the supra-orbital protuberance to the sphenoid.

The interior of the frontal is perfectly smooth for its cerebral portion, the surface being only marked with two slight depressions for the rhinencephalon; the walls of the nasal chamber, on the other hand, are irregular, and marked in various ways. A strong ridge depends from the median line, marking the junction of the vertical ethmoidal plate, and dividing the interior into lateral moieties. The superior portion of the surface of each is hollowed for the reception of the upper turbinal convolutions; the lower portion (inner surface of orbital plate of frontal) is marked by several (four or five) longitudinal, horizontal lines, nearly parallel with each other, corresponding with the middle convolutions of the turbinate bones. There are a few other irregularities, not necessary to particularize, which, like those just described, relate to the convolutions of the spongy bones.

The *nasals* remain distinct from each other, and from the surrounding bones with which they are suturally connected. They are long and narrow, nearly straight, in mutual apposition along the median line. The anterior half is narrowly linear, the posterior has a lateral expansion; so that the fronto- and maxillo-nasal sutures enclose a diamond-shaped space upon the lower forehead; the naso-intermaxillary takes the place of the naso-maxillary suture for the anterior third of the bone. These sutures are squamous, the nasal overlapping the maxillary and intermaxillary. The superior surface of the nasals is smooth and nearly plane; the inferior aspect of the conjoined bones is a half-cylinder. The nasals terminate in a point, which falls short of the end of the jaw; "rostral" bones are not developed.

The ascending ramus of the *intermaxillary* is wedged in between the nasals and maxillaries, extending about an inch upon the cheek, overriding the side of the nasal, and being in turn overlapped by the maxillary. The rami are curved, with the convexity outward, at first divaricating from each other to increase the calibre of the nasal aperture, and then somewhat approximating, and also each curling upon itself, as the alveolar borders come to meet on the median line in front. The palatal plate of each bone is almost divided into two longitudinal parts by an extensive fissure — the incisive foramen — which nearly reaches the alveolus. This foramen is not completed behind by the intermaxillary; it is simply a slit, so far as that bone is concerned. The median moiety of the palatal plate is an extremely long and attenuated spicula whose extent is not visible from below in the articulated skull, as the palatal plate of the maxillary overlaps it. The lateral moiety is much shorter, as well as broader; it terminates at the anterior border of the socket of the upper canine. The intermaxillaries are never confluent with each other or with surrounding bones. Each contains five teeth.

The *maxillary* is large, and has numerous strong processes. Its surface is smooth; the foramen appears just above the first or second premolar, opening upon a slightly depressed space, in advance of which is the bulging that denotes the insertion of the great canine. The nasal plate or process curves toward the nasal bone, and unites with the latter for about half its length, being anteriorly cut off by the intermaxillary; the posterior prolongation of this plate, in the form of a sharp pointed process, reaches the frontal. A deep excavation in the border of the bone, just below the process, indicates the seat of the lachrymal. Posteriorly the bone sends upward a large, stout, zygomatic process, for union with the malar, in a manner to be more particularly noticed under head of the latter. The alveolar border is strongly developed, particularly behind; it narrows anteriorly, and is deficient at the wide interspace between the first and second premolars. The palatal plate or process meets its fellow along a perfectly straight median line. Besides being nicked anteriorly to perfect the incisive foramen, it is deficient posteriorly, where the palatal plate of the palatine completes the bony roof of the mouth; and is, moreover, deeply fissured to form the posterior elongated vacuity, described below. Both upper and under surfaces of the palatal plate are nearly smooth; on the latter, however, a shallow but distinct groove may be observed running from the posterior fissure to the root of the canine. The posterior border of the bone, between the malar and palatine, is thick, smooth and concave; it is continued as a process just behind the last molar, taking part in the formation of the most postero-external of the ten openings in the bony palate. The share that the zygomatic process takes in the formation of the outer wall of the orbit is inconsiderable, though greater than appears on viewing the bone from the outside. The floor of the orbit — what little there is of it — is maxillar. The surface of this part of the bone is traversed by a groove, in which lies the maxillary division of the trigeminus, which is conducted by this means along the orbital floor into a bony canal, whose outlet is the maxillary foramen. The bone bears upon the inner surface of its ascending plate, the lower or anterior turbinal bone — a spongy convoluted mass, of extremely delicate texture, which nearly fills that part of the nasal chamber not occupied by the ethmo-turbinal. The maxillary is permanently distinct from all of its surroundings. The alveolus bears eight teeth

The *malar*, which is a large, stout bone, forms the greater part of the zygoma. In general form it is a little arched, a little curved outward, compressed, expanded vertically, and with extensive, very oblique sutural terminations. The anterior extremity chiefly unites with the maxilla by overlapping; but its extreme point is received into a slight pit in the latter bone, while the extremity of the zygomatic process of the maxilla is firmly wedged in a similar but larger depression in the malar itself. The suture is thus made remarkably strong. The posterior extremity of the bone is more irregular. A thin, scale-like lamina is appressed against the inside of the squamosal: the bone then continues, by its stout under border, to the glenoid cavity—its extremity being cupped to become continuous with the articulating surface. The lower margin of the shaft of the malar is concave, and presents a well marked, oblique bevelling for masseteric attachment. The upper margin is straighter, but is anteriorly cut away a little to afford a slight concavity, which is the lower margin of the bony rim of the orbit; and, still further forward, is broken by articulation with the lachrymal. The obtuse posterior termination of the bone gives a partial wall to the front of the glenoid cavity.

The *palatine*, though singularly irregular in contour, and curiously wedged in between several bones, can always be detached entire from its connections. It is essentially composed of three plates or processes. The orbital forms a great part of the inner wall of the cavity of that name, completed by the frontal and lachrymal. It is an excessively thin, delicate, osseous scale, nearly vertical, with a gently arched upper border, by which it bestrides, as it were, the contiguous border of the frontal, part over-, part under-lapping. A large foramen obliquely perforates the middle of the base of this upright lamina. An extremely attenuated sharp-pointed spicula of bone forms a horizontal process directly backwards, lying closely appressed upon the inner surface of the spheno-pterapophysis. This process augments what would otherwise be a slight spheno-palatine articulation. Its base gives off a narrow flange-like lamina of bone, projecting horizontally inward, serving to define the entrance to the posterior nares. The palatal process may be taken as the main body of the bone. This is transversely expanded, and sufficiently thickened to form the posterior termination of the bony palate. Its posterior margin is especially stout, and directly transverse, forming an acute angle with the lateral border. The inner border is apposed to its fellow of the opposite side. The anterior border is very irregular. Beside interlocking by semi-squamous suture with the maxilla, it is further broken and interrupted by a deep notch—the posterior margin of the largest palatal aperture; and another, more posterior and external, similarly encloses, with the maxilla, a second foramen. A large quadrilateral aperture exists wholly within the palatine, in front, near the median line; and there is a very minute perforation close to its posterior margin.

With the exception of the tympanics, and ossicula auditûs, the *pterygoids* are the smallest and most delicate of the cranial bones, and their connection with the skull is, if possible, even looser; it is almost impossible to preserve them *in situ*. They are excessively thin and fragile laminæ, inserted, by their longest edge, into the slight groove between the posterior prolongation of the palatines and the sphenoidal pterapophyses, nearly vertical in position, abutting anteriorly, by their enlarged extremities, against the termination of the bony palate. The presence of these flimsy little bones would seem to be merely in obedience to morphological law; they can subserve little, if any, teleological purpose. I do not comprehend the statement (Owen, Comp. Anat. II, p. 346) that the pterygoids "repeat the connections they present in birds." In this marsupial, at least, these bones, so far from having any connection with the tympanics, do not reach half way from the palatines.

The *lachrymal* is of large size, and forms a considerable part of the orbital wall. While its general shape is that of a thin, flattened, triangular scale, it has one stout process, sticking outward and backward, for articulation with the malar—the point of the process being thrust into a pit in the upper corner of the latter, like a tooth in its socket. The part of the bone that forms the rim of the orbit at the anterior canthus of the eye is thickened, and presents a perfectly smooth surface, of a semilunar shape, whose convex border fits the concavity in the margin of the maxilla. The large opening of the lachrymal duct appears in the centre of this surface, leading forward into a canal that runs the whole length of the bone before terminating in the nasal chamber. This foramen appears just outside the orbital rim—upon the face, rather than in the orbit itself. With the exception of the malar articulation above described, all the sutures are squamous; the edge of the bone overlaps both frontal and palatine, but is overlapped by the maxillary, and this to such an extent, that only its thickened central portion appears upon the outside. The inner surface forms part of the lateral wall of the nasal cavity; it is a little concave, and slightly impressed with a few irregular ridges and depressions.

The *vomer* and *ethmoid* (ethmo-turbinal—olfactory sense-capsule) may be most conveniently noticed together, as they form virtually one bone. In superficial extent it is one of the largest bones of the head; but it is very light and delicate in texture, the spongy masses forming by far the greater part. In shape it corresponds, in a general way, to the cavity of the nasal chamber, being something of a parallelopipedon, but narrowing supero-inferiorly from behind forward; similarly wedge-shaped transversely from before backward, and with a deep excavation at its upper posterior corner; thus resembling, except in the latter particular, the frustrum of a double wedge. It consists of a sufficiently strong vertical median plate (perpendicular ethmoidal lamina=coalesced prefrontals?) straight edged above and below, nearly vertically truncated anteriorly, and bearing upon either side the spongy convolutions, and bounded below, as by a horizontal keel, by the long, slender vomer, which coössifies throughout nearly all its length. The posterior lower corner is the only point where the bone acquires any decided solidity. At this point the bone runs out into a knob-like process, with vertical sides, convex base, and slightly concave superior surface; this process is received in, and exactly fits, the interspace between the anterior margins of the orbito-sphenoids, thus projecting into the cranial chamber and forming a protuberance, just behind the cribriform plate, upon which the rhinencephalon rests; it also arches over, and forms the roof of the passage over the presphenoid, converting the grooves on either side of this bone, by which the optic nerves escape from the cranium, into canals; behind, these canals inter-communicate, there being no median septum; but anteriorly they are separated by the articulation of the vomer with the presphenoid. This process is thus hidden within the cavity of the cranium; but the knob that is the truncated base of the vomer, and is borne upon its under surface, appears, upon viewing the outside of the skull from below, as a smooth bone, lying deep between the spheno-pterapophyses, abutting against the end of the presphenoid, and in direct forward continuation of the latter into the nasal cavity, forming the roof of the posterior nares. Further on the bone passes between, and is concealed by, the palatals—a faintly marked groove on either side of the vomerine knob betraying the passage of the optic nerve into the orbit. The cribriform plate of the ethmoid begins at the anterior base of the inter-orbito-sphenoid process of the bone, and thence curves upward as it passes forward, in nearly the quadrant of a circle, thus finally gaining the top of the bone, and almost or quite touching the inside of the frontal. At its lower part the sieve is flat from side to side; more anteriorly and superiorly it is transversely concave. It is pierced with innumerable foramina, of varying size, but all small, very evenly distributed over its whole surface, with no indication of a median dividing line, except just at the antero-superior extremity, where there is a very small space free from holes, and also a slight projecting point—obviously a rudimentary crista galli. The lowermost foramina lead obliquely downward as well as forward; the upper ones directly forward; the different laminæ of the spongy substance having corresponding direction. It would be difficult, even were it desirable, to describe the details of the spongy convolutions: suffice it to say that they form large masses on either side of the median plate, corresponding in contour with the latter, and consist of very numerous exceedingly thin laminæ, mostly lying flatwise, and running from behind forward, partitioning each half of the nasal chamber into numerous small inter-communicating passages, each of which is lined by a duplicature of the common mucous membrane under which the olfactory nerves ramify. Upon the posterior and external part of the under surface of each spongy body the laminæ unite to form one continuous thin plate, that directly roofs that part of the nasal passage; more anteriorly, and toward the median line, the same surface comes in apposition with the spongy mass that is attached to the inside of the superior maxillary; and along this part of it there is no such coalescence of the extremities of the laminæ into one smooth plate; the under surface of the maxillary sponge (inferior turbinate bone) continuing forward the roofing of the nasal passage. Not as in those mammals in which the ethmoid takes part in the formation of the orbital wall, and in consequence develops, by external coalescence of its laminæ, a smooth surface ("orbital plate of ethmoid," *e. g.*, in man) the lateral surface of the spongy mass does not present a continuous osseous plate; it shows throughout the edges of the laminæ, penetrating its substance, and the duplicatures of the mucous membrane; and lies wholly inside the lateral plate of the frontal, vertical plate of palatal, and orbital plate of lachrymal, which three together form the inner (mesial) wall of the orbital cavity.

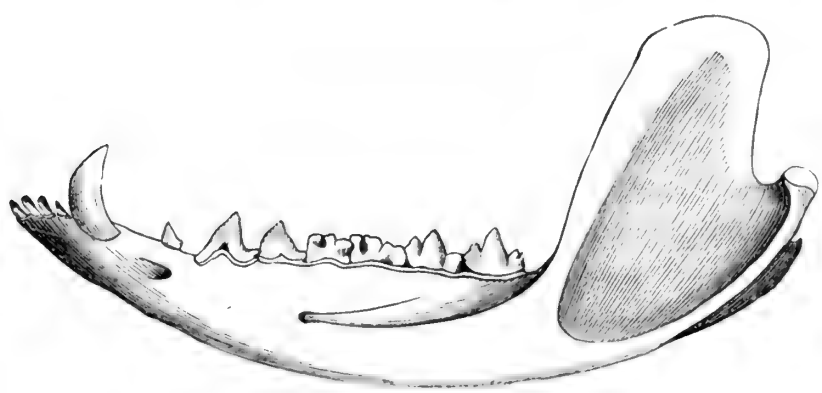


Fig. 7.

Fig. 8.

In the *mandible* (fig. 7, lateral view, left side; fig. 8, from above) all traces of the several bones of which it may have been originally composed, disappear at an early period; each lateral moiety was found entire in the youngest specimens examined. At the same time, the union of the halves always remains a simple synchrondrosis; and the jaw readily comes apart without maceration. The rami meet at an acute angle (of about 30°); the symphysis is an inch long, very narrow, and almost horizontal; the course of each ramus is exflected, so that the two sides lie nearly parallel for this distance. The body of the bone is twisted upon itself, so that the alveoli, at first perpendicular, lean more and more outward from behind forward; the teeth, as a series, thus lie oblique to the long axis of the jaw; and while the molars are upright, the premolars slant a little outward, and the canine and incisors have a successively increasing outward and forward obliquity, (*vide* figs. 7 and 8). There are twelve teeth on each side. Taking the line of the alveolar border as the middle longitudinal axis of the mandible, the lower border of the bone represents an unbroken arc of a circle, from incisor teeth to condyle: the latter is situated much above the long axis just assumed.

There is no vestige of "an angle of the jaw," as such. The portion of bone that forms this part in placental carnivores is here inflected as it were, and appears as a sharp ridge, or plate, extending at right angles with the plane of the coronoid plate into the inter-ramal space toward its fellow of the opposite side. This ridge ends in a sharp pointed process, directed backward. The lower border of the jaw presents no noteworthy features until we reach the beginning of this remarkable process; there it becomes flattened, and transversely widened; a smooth, flat triangular surface being produced, mostly by the process just described, but partly, also, by a ridge of bone looking horizontally outward, and continued directly up to the condyle. The inner pointed process is separated from the corresponding side of the condyle by a deep and wide notch. A small and rather irregular groove leads obliquely from the notch to the outside of the condyle. The articular surface of the latter is greatly extended in its transverse diameter, and very narrow in the opposite direction. The coronöid process is enormously developed, seeming to virtually constitute the "ascending ramus of the jaw." In the articulated skull, it reaches above the superior margin of the zygoma. Its shape is liable to considerable variation with individuals; besides which, its general direction from above downward appears to change with age. In a young animal, I find that the backward obliquity is sufficient to carry the apex directly over the condyle; in adult specimens the coronoid is much more upright, as represented in the cut. The coronoid is very thin—almost diaphanous; the anterior border is thickened, and descends with a slight forward convexity to the main part of the jaw a little behind the last molar; the apical and posterior borders are very sharp; the former is obtusely rounded, the latter descends in a nearly straight (but sometimes sinuous or otherwise irregular) line a little below the level of the condyle, up to which it then curves, forming a well-marked notch. The inner surface of the coronoid is smooth, and continuous with the general surface of the jaw; the outer is roughened for muscular attachment, and forms a broad, shallow fossa, determined by the thickening of the bone along the anterior border of the coronoid itself, and the external ridge along the under border of jaw, leading up to the condyle. One would scarcely predicate, from the general contour of the mandible, the great force that the animal can exert with its teeth; but the enormous temporal and masseter muscles, acting upon the greatly expanded coronoid process, more than compensate for the disadvantages that result from the length and straightness of the jaw, and the position of the condyle. The dental nerve and vessels enter the jaw at a large oval foramen situated at the middle of the base of the internal angular process above described. A similar but smaller foramen appears on the outside of the jaw, opposite the interspace between the first and second premolars; a third, still smaller, appears below the molar-premolar interspace.

c. Of the Skull as a Whole.—(Fig. 9, upper, fig. 10, under, and fig. 11, lateral, view).

Having treated of the skull as four modified vertebræ, and of its individual bones, it only remains for me to describe the whole resulting from the coherence or coalescence of the numerous parts. The teeth were considered in another connection.

Exclusive of the lower jaw, the general shape of the skull is that of an elongated cone, contracted at the base, flattened below, bulging at the sides, swollen across the forehead. There is nothing of the pear-shaped contour commonly seen in the skulls of carnivores, resulting from the expanded brain-case. The width of the cranial portion proper is produced mainly by the widespread zygomata, and the height by the sagittal crest. In consequence of the small size of the brain, in this as in other marsupials, the pericephalon forms but a small proportion of the entire skull—the greater part of which is appropriated to the formation of the nasal and buccal cavities, and the parts accessory to the movement of the jaws. The narrowest point of the skull (excluding the zygomata) is, in fact, across the anterior part of the cranium proper, where the hour-glass contraction is so great that the width of the cranium does not exceed that of the premaxillaries. The facial part of the skull is almost as long as the cranial. The greatest width across the zygomata is just half the total length. The height varies with individuals according to the development of the sagittal crest; in general it amounts to about a fourth of the total length. The same measurement applies to the height of the cranium proper and to the distance from the alveolar border to the fronto-nasal suture—the depth of the upper jaw thus surpassing that of the brain-case, since fully a fourth of the

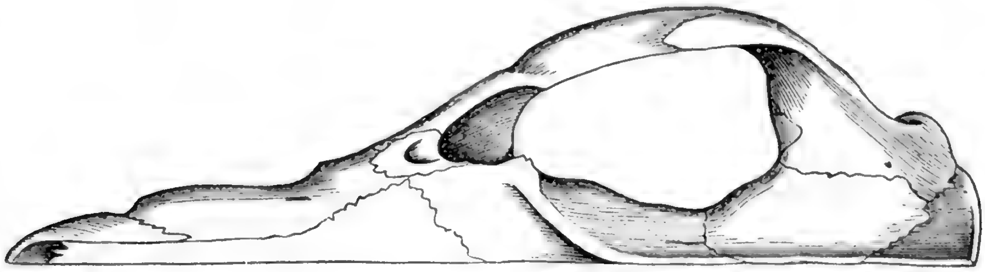


Fig. 9.—Skull from above.

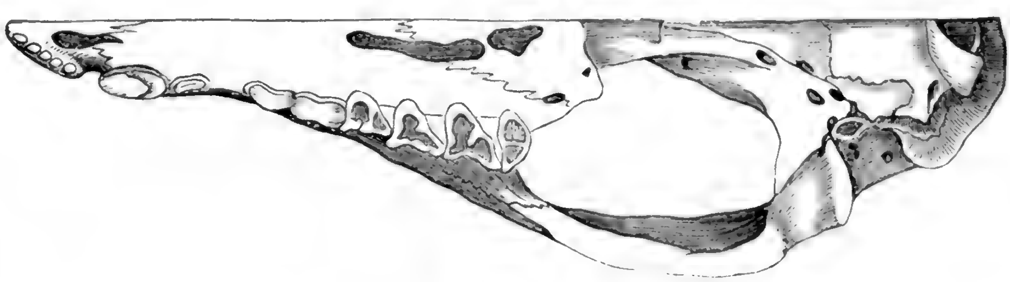


Fig. 10.—Skull from below.

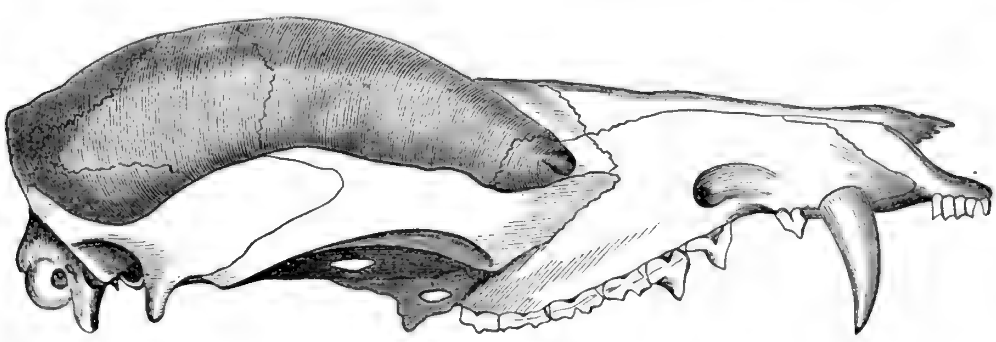


Fig. 11.—Lateral view of the Skull.

cranial depth is due to the elevated comb of bone. The inter-mastoid distance is less than the greatest inter-alveolar. The bony palate occupies about three-fifths of the length of the floor of the skull. The circumference of the constricted part of the cranium scarcely exceeds that of the muzzle measured just in front of the premolars. These various admeasurements display, very instructively, the predominance of the sensory over the ratiocinative faculties. The swollen and elongated face contrasts strongly with the contracted brain case. The expanded zygomata and enormous temporal fossæ, bounded by high, sharp crests, are as suggestive as the massive jaws themselves, with their long tushes. The shape of the bare skull betrays the cunning and ferocity of the beast, as plainly as these qualities are expressed by its physiognomy during life.

The base of the skull is semicircular in contour, continuously bounded laterally and above by the strongly developed occipital (no longer "lambdoidal") crest, the backward projection of which converts what would otherwise be a plane into a depression, all of which is roughened for the firm implantation of the nuchal muscles. This space is always traversed by the very irregular curved line, marking the junction of the par- and ex- with the super-occipitals and mastoid: and, except, perhaps, in very old skulls, by a second line, straight, vertical and median, at the junction of the exoccipitals over the foramen magnum. The latter is broadly oval in shape, widest transversely; its lower border is on a line with the straight edge of the base of the skull. The condylar protuberance is considerable; the condyles are lateral in position, looking outward, forward, and downward; superiorly they are separated by a wide interval, along which the rim of the foramen is thin and sharp; inferiorly the articular surfaces nearly touch each other. A deep notch separates them from the paroccipitals: the latter are stout, conical processes, projecting straight downward, till their apices reach the plane of the posterior molars. Their bases abut externally against the mastoid processes—two roughened, irregular prominences that complete the lateral corners of the semicircle. A small foramen perforates the posterior aspect of the mastoid, high up, opposite the most posterior root of the zygomatic portion of the squamosal. The condylar canals emerge from under the edge of the articular facets, in the depression between the latter and the paroccipitals. A minute foramen perforates the basioccipital on either side a little in advance of the condyles.

The superior aspect of the skull is abruptly bounded posteriorly by the transverse elevated occipital crests; laterally by the strong, wide-spread, curved and arched zygomata and perpendicular surface of maxillary and premaxillary bones. The sides of the cranium proper are depressed, roughened for the attachment of the temporalis and masseter, and present the hour-glass contraction already mentioned. They are only expanded and vaulted posteriorly between the roots of the zygomata. The surface is traversed by lines denoting the fronto–, spheno-, squamo– and occipito-parietal sutures; the latter is very frequently obliterated with age. The sides of the brain-case meet above, at an angle along the median line, where one of the distinguishing peculiarities of the opossum's skull is exhibited. This is the development of an enormous "sagittal" or interparietal crest or comb, extending unbroken from the crista occipitalis to the middle of the os frontis. The elevation of this crest increases with age, as usual, and is moreover subject to variation with individuals; beside which discrepancies, I think that I observe a difference dependent upon sex; the crest in the male being higher and thicker. The lateral moieties of the parietal portion of the crest usually remain separable, except in very old skulls. Owing to the early coalescence of the frontals, this portion of the crest is usually found single. From the point of subsidence of the crest into the common coronal surface, two ridges diverge at an acute angle and run forward and outward along the frontal to the superciliary protuberances, marking the extent of attachment of the temporals to the frontal. The sagittal comb is thus forked, as it were, anteriorly.

The roof of the nasal cavities appropriates most of the superior surface of the skull; occupying all the surface anterior to the supraorbital ridges, and the forks of the parietal crest. This surface is everywhere smooth; the most marked irregularity of contour is a slight concavity on either side in the superior maxillaries, where the lower canine abuts. It is divided longitudinally for three-fourths of its extent from before backwards by the nasal suture—the neural spines never coalescing; there is no inter-frontal suture in adult skulls; the other sutures are the irregularly curved and arched naso-maxillary, the fronto-nasal, the naso-premaxillary, maxillo-premaxillary, and fronto-maxillo-lachrymal. A great part of the os lachrymale extends upon the superficies of the face; the opening of its duct lies outside the orbit. The only other opening upon the face is the foramen maxillare—situated just above the interspace between the second and third premolars, and of great size. The nasal aperture, of large size, is partially roofed over by the pointed projection of the two nasal bones, and completed at the sides and in front by the produced premaxillaries.

Vast temporal fossæ result from the constriction of the brain-case, the great outward sweep of the zygomata, and the imperfection of the bony orbits. The zygomatic process of the squamosal may be traced backward to its origin in the mastoid portion of the crista occipitalis as a prominent bony ridge, overarching the tympanic cavity. As soon as it fairly leaves the squamous part of the bone, it sends downward the strong process that forms the back wall of the glenoid, while at the same time its superior margin begins to rise. The superior margin of the zygoma is thin and sharp; its upward convexity is due as much to the expansion of the bone itself, as to the concavity of the opposite margin. The latter—the under border—is thickened, and has a well marked, oblique bevelling; its concavity is greatest anteriorly, where the malar bends downward to join the large out-standing zygomatic process of the maxillary. Posteriorly, the lateral view of the zygoma shows, at the termination of the malar, a deep excavation—the profile of the glenoid. The side of the zygoma is traversed by the oblique squamo-malar suture, which is never obliterated. Anteriorly, the superior margin of the zygoma is suddenly thickened, and becomes moderately concave—this portion defining the extent of the orbit. The structure and relations of the zygomatic arches are clearly displayed in the accompanying figures (9 and 10); these are such as would lead us to infer the nature of the animal's food, were we dealing with a placental mammal; but in the present order their indications are not so reliable.

The very imperfect orbits appear as parts of the temporal fossæ, having no bony wall posteriorly, and being only partially floored by the maxillaries. The contour is indicated externally by the above-mentioned concavity of the malar, anteriorly by the stout lachrymal, internally by a very slight superciliary ridge and more decided supraorbital protuberances. The lachrymal, frontal, and palatine make up the inner walls; in the formation of which the last named takes greatest part. This smooth, orbito-nasal septum is distinguished from the directly continuous temporal fossa by a slight ridge extending obliquely downward and backward from the supraorbital prominence to the orbitosphenoid, forbidding encroachment of the temporalis upon the orbit itself. The outer wall of the orbit seems to be formed chiefly by the malar, on viewing it from the outside; but the squamous overlapping of the maxillary invades the inner surface of this wall; the maxillary has greater share in the production of the anterior, elongated, conical portion of the orbital cavity not occupied by the eyeball. This conical portion is the entrance to the canal whose external aperture is the maxillary foramen; and transmits the superior maxillary division of the trigeminus. The foramen of exit of the nerves that go to the eye are all situated behind the orbital cavity proper; the ductus lachrymalis itself is also outside of the orbit. The palatal foramen, however, is fairly within the orbit; it is circular, and of large size.

The glenoid fossa has the peculiar structure that is characteristic of many marsupials, being formed at the meeting of three bones—alisphenoid, squamosal, and malar. By far the greater part of it, however, is squamosal. The end of the malar is just nicked to complete the cavity antero-externally; a long, slender, horizontal, transverse process of the alisphenoid just touches the malar, and so forms the antero-internal border. The shape of the fossa indicates the nature of the articulation, which is strictly ginglymoid; there is no convexity of surface in the glenoid, nor such contour as to provide, however imperfectly, for lateral motion of the jaw. The fossa is directly transverse, wider than long, plane from side to side, and very concave antero-posteriorly. The concavity is produced mainly by the wide descending process of the squamosal, which affords an abutment for the mandible, preventing retraction. Anteriorly, there is only a trace of such a wall.

The bony palate is of great extent, reaching more than halfway from the incisors to the foramen magnum. It is carried backward beyond the last molars by the palatal process of the palatines, terminating with a thick, directly transverse margin, developing on either side a stout conical process, whence the sides slope obliquely forward and outward to the last molars. The palate is concave in all directions—most so from side to side, in consequence of the well-developed alveolar processes. It is longitudinally divided into halves by a straight line, denoting the apposition of each palatal, maxillary and premaxillary with its fellow of the opposite side; this line is never obliterated by confluence of these pairs of bones. There are ten palatal openings, symmetrically placed in pairs. The incisive foramina are two narrowly linear apertures, side by side, close to the median line, distinguishing the palatal processes of the premaxillaries from their alveolar portions. The perforations are closed behind by the maxillaries, which, however, take part in their formation by being nicked for about an eighth of an inch. The maxillary apertures, situated opposite the three last molars, are of large size (.66-.75 of an inch, or more, in length), and narrowly elliptical, or even linear, though their contour is frequently somewhat irregular. The class of osseous perforations to which the present foramina belong is obnoxious to irregularities of size and shape, and consequently can only be defined in loose terms. Most of the perforation occurs in the maxillaries; the palatals bound the posterior third or even half. Immediately behind these openings there are two smaller (but still large) perforations in the palatal processes of the palatines, placed close together, and generally presenting a four-sided contour. Externally, and a little behind the latter, the same processes of bone are again perforated, this time by oval foramina, situated close by the external border. Finally, there is a minute, circular foramen upon either side, just within the transverse, posterior termination of the palate. Notwithstanding these numerous fissures in the osseous roof of the mouth, the palate is much more perfect than that of some other marsupials, as, *e.g.*, the *Perameles lagotis*, in which[1] "the bony roof of the mouth is perforated by a wide oval space extending from the second premolars to the penultimate molars, exposing to view the vomer and convolutions of the inferior spongy bones in the nasal cavity."

The remaining portion of the floor of the skull may be here passed over more rapidly, as the most of the points have been already noticed in speaking of the several bones that compose it. Its general contour is that of a lozenge, as far forward as the constricted part, beyond which it enlarges again. The central smooth tract is crossed by the line of separation of the basi-occipital and -sphenoid; rarely, if ever, obliterated. Just in advance of the most constricted point, a similar, but shorter, transverse fissure indicates the termination of the sphenoid; this is more liable to disappear by confluence of the following segment. On either side of the basi-occipital, the petrosals determine the extent of the oblique fissuræ laceræ. The moderately developed bullæ osseæ form smooth, convex protuberances just outside the petrosals; the entocarotid foramen lies immediately anterior, and a little internal; the foramina ovala et rotunda a little further forward; the optic still more in advance. The sphenoidal "pterapophyses" rise on either side to meet the palatals, partially forming the side walls of the conduit that leads into the posterior nares. These walls are completed by the thin, expanded falciform pterygoids, vertically lodged by their very delicate and attenuated process in a groove in the sphenoid pterapophyses. The auditory fossæ occupy the postero-external corner of the skull, appearing as deep notches between the articular processes of the squamosal and the mastoid, limited internally by the petrosals and sphenoidal bullæ. There are two oval foramina, side by side, in the outer part of the notch; just below them, the delicate tympanic ring is seen suspended at the entrance of the meatus auditorius.

2. The Other Vertebræ.

a. Cervical Vertebræ.—(Figs. 12 and 13). The neck-bones (which are seven in number, as in other marsupials, and nearly all mammals), form a strong compact pile, so closely locked together that little motion is possible except at either extremity. Fixation of this portion of the spine is effected both by large overlapping lateral processes, and by the enormous development of the spines of most of the vertebræ. Extension beyond a right line is only permitted at the base of the neck; twisting is mostly, if not wholly, confined to the atlas, and only an inconsiderable amount of flexion is attainable. Five or six of the vertebræ, indeed, virtually act almost as one bone, and mobility is sacrificed to stability. Nearly all the motions of the neck arise between the first dorsal and seventh cervical, where movement is very free, in compen-

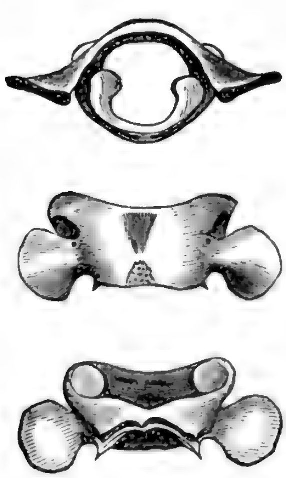


Fig. 12.
Three views of the Atlas.

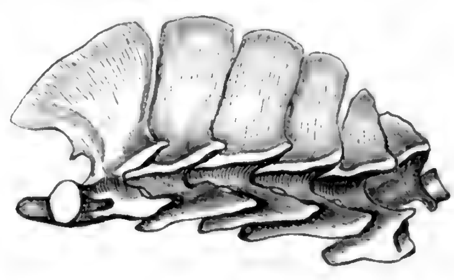


Fig. 13.
Six Cervicals, lateral view.

[1] Owen, Comp. Anat. and Phys., II, p. 346. The author considers the vacuities of the bony palate of marsupials —animals forming the transition from oviparous to placental vertebrates—as an approximation toward the defective condition of this part of the avian skull.

sation for its loss elsewhere. Rotation of the atlas around the odontoid is also very perfect. Need of fixedness in the cervical portion of the spine results from some of the habits of the animal, which roots, pig-like, in soft earth and decaying vegetation, in search of the worms, etc., that form part of its food. The great spinous processes, as well as the high occipital crest, are required for the attachment of the large muscles by which such actions are rendered easy. The flexion at either end that the column is capable of, undoubtedly has reference to the care of the contents of the pouch.

Each of the cervical vertebræ has peculiarities whereby it may be recognized; though there is comparatively little difference between the third, fourth and fifth. The following remarks apply to the conjoined bones as a whole, exclusive of the atlas: The neural spines together form a massive arch, culminating at the third bone, rapidly descending in front to the atlas, more gradually sloping behind to the seventh, which has only a rudiment. The middle portion of the arch is the heaviest, widest across, and most closely locked. The neurapophyses are short, thick, heavy and vertical. At the third vertebra they do not project laterally beyond the side of the spines, though they become thinner, longer, more oblique, and spread further apart upon successive vertebræ from before backward. They develop large pre- and post-zygapophyses, with very oblique articular surfaces, largely overlapping each other, and firmly interlocking. These processes together form a prominent serrated ridge along the side of the column, separated from the series of transverse processes by a wide and deep sulcus. The "transverse" processes are of great size, and remarkably expanded in their longitudinal axis. Their free terminal edges are placed a little obliquely, so that the posterior prolongation of each one overlaps the succeeding, and underlies the preceding, by which means the immobility of the column is augmented. The seventh alone does not present this longitudinal expansion of its transverse process. The pleurapophyses are confluent throughout the series, producing vertebrarterial foramina. Slight hypapophyses are given off by all the vertebræ, appearing as a continuous ridge along the under side of the centrums, which are otherwise broad and flat underneath. A transverse section of a centrum is nearly oval; of the neural canals somewhat horse-shoe-shaped; or rather stapeform, with its sides a little approaching below, and a slightly convex floor; highest anteriorly, widest posteriorly. The ordinary relative position of the vertebræ is that which approximates their spines most closely; hence the seventh, whose spine is deficient, surmounts, rather than directly follows, the sixth, guiding the cord, by a gentle curve, into the dorsal series. Were it not for this, the change in direction, resulting from the difference in the axes of the neck and back in the animal's ordinary attitudes would be at an abrupt angle. The entire series of vertebræ, viewed from the under side, presents a pyramidal figure, whose apex is the odontoid process; the bodies of the vertebræ, and their transverse processes gradually narrowing from behind forward.

The *atlas* (fig. 12) is notable for the great expansion of the di- and neur-apophyses. The latter form a broad, heavy arch, over the smooth surface of which the advancing and overlapping spine of the axis plays freely from side to side. The lateral processes form two large, thin, flat, subcircular plates, moderately pedicellate, reaching on either side far beyond the corresponding processes of other vertebræ, and serving as powerful *points d'appui* for muscular action. They have no obliquity, in the longitudinal axis, but extend a little behind the posterior margin of the neurapophyses. The so-called "body" a little behind the posterior margin of the neurapophyses. The so-called "body" (hypapophysis) of the atlas, unlike that of some marsupials, in which it does not advance beyond the cartilaginous stage, is completely ossified. The ossification appears to take place at an early age, as I find the bony ring perfect in a specimen in which the epiphyses of the long bones are still distinct. The ring, unlike the broad neural arch, is slender and delicate. Within, it is scooped away for the lodgment of the odontoid, which appears but loosely confined, so far as lateral motion is concerned. The contour of the inside of the ring and neural arch together is, in a general way, circular; but on looking through the aperture, a slight hour-glass contraction is observed, dividing the canal into two parts. The upper conducts the spinal marrow, the odontoid revolves in the lower; they are of nearly equal size; the upper is wider and flatter. The constriction is produced partly by the little bony eminences that serve for the attachment of the check ligament; but more by the inward expansion of the well developed post-zygapophyses. These articular plates are raised above the general level of the bone, with their sharp, well-defined edges above; below they gradually subside into the articular surface for the odontoid process. The condylar articular facets appear as large, well marked depressions. There is no vertebrarterial foramen; the vessel merely grooves the bone as it passes by the root of the transverse process. Anteriorly, the neural arch is perforated on either side by a venous canal, running directly transverse, and opening on the outer surface into a deep, distinct groove that winds around the front of the base of the transverse process. Inside the arch, the canal terminates abruptly at the inner margin of the condylar facet, but varies in different specimens; sometimes it is little more than a simple perforation, terminating a long groove; in others, the greater part of this groove is bridged over by bone. In one individual I observed a difference between the two sides of the bone. The left presented the groove and simple perforation; the right, a long canal, whose bony arch was deficient in the middle, displaying the vessel after it had been once hidden. This interruption caused the most lateral part of the canal—that at the root of the transverse process—to simulate the vertebrarterial foramen in everything but position.

The neural spine of the *axis* is the remarkable part of that bone. It is an enormously expanded, upright lamina, thicker behind than before, reaching its greatest height posteriorly, where it rises vertically above the line of articulation of the next vertebra, and thence slopes downward and forward to reach the anterior border of the atlas. This forward projection of the spine lies upon the neural arch of the atlas, riding freely from side to side. The post-zygapophyses appear as two flaring ovals at the back part of the root of the spine, though really borne, as usual, upon the neurapophyses. The pre-zygapophyses seem situated upon the anterior projection of the body of the vertebra; they are stout, prominent processes, whose articular facets are well defined by a sharp border, except just in front where they appear more or less continuous with the articular surface of the odontoid process. The latter presents no special peculiarity, being simply a conical knob. The vertebrarterial canal is perfect. The greatly produced posterior prolongation of the transverse process projects outward, downward and backward; there is no corresponding anterior prolongation, such as exists in the other cervical vertebræ; this portion of the process subsiding into the body of the vertebra just at the termination of the arterial foramen, which it bounds below.

The *third* cervical is the opossum's "vertebra prominens"; the spine here reaches its maximum of development in height and width, though wanting the antero-posterior expansion of that of the axis. It forms a massive, upright, four-sided pillar, slightly expanded at the top, and slightly grooved from top to bottom on its anterior and posterior sides, for the more complete interlocking of the contiguous vertebræ. The spine is perfectly vertical, and just as thick transversely as it is antero-posteriorly. The pre- and post-zygapophyses are alike in shape; their articular faces are in parallel planes, looking in exactly opposite directions. The transverse process here first shows an anterior downward and forward prolongation, as well as a posterior one, beginning the series of lateral overlapping and interlocking that has been already alluded to. The *fourth* vertebra is like the third in all essential particulars, but may be distinguished by its somewhat shorter spine, with a slight backward inclination and greater breadth in front than behind. The *fifth* again repeats the characters of the preceding, but the spine is much reduced, with a decided backward inclination, and narrower across than in the longitudinal direction; but it is still a pillar. The *sixth* is decidedly modified in two respects. The spine is a simple, short, pointed process, scarcely half the height of the preceding. Both zygapophyses are very prominent. The transverse process is unique in size and shape; neither that of the vertebra which precedes, nor that which follows, showing any approach to its peculiarity. This consists in a remarkable expansion downward and outward, producing a broad, thin, oblique plate of bone, lying within and below the line of the transverse processes of the other vertebræ. This plate is overlapped by the backward extension of the process of the preceding bone, but does not in turn overlap, or otherwise restrict the motion of the succeeding vertebra. The part of the process that corresponds to the overlapping portion of the other vertebræ, here stands out, with but slight backward inclination, appearing as a sharp spine springing from the back part of the root of the expanded plate, with the vertebrarterial foramen at its base. The *seventh* would scarcely be taken for one of the cervical vertebræ, were it not betrayed by the foramen. The spine is rudimentary, merely a little sharp point of bone, recognized by its position. The pre-zygapophyses project far forwards. The transverse processes have no overlapping by longitudinal expansion; they are slender spicula, projecting straight out sideways, perforated at the base. The neural arch is broad, both crossways and longitudinally, and projects back of the centrum, partly overlapping the arch of the first dorsal; its edge is nicked in the middle for the reception of the first dorsal spine. Such are the modifications of the several cervical vertebræ, resulting in the production, in this part of the spinal column, of the conditions noticed in speaking of the neck as a whole, and for the purposes there stated.

Dorsal Vertebræ. — (Fig. 14.) As in most marsupials, the dorsals are thirteen in number. The transition from the last cervical to the first dorsal is abrupt and well marked. At the opposite extremity the characters of the dorsal merge insensibly into those of the lumbar series. The general tendency of the conjoined dorsals is to assume the shape of an open S, or rather italic *f*, the lower front part of which is completed by the upturned cervical series.

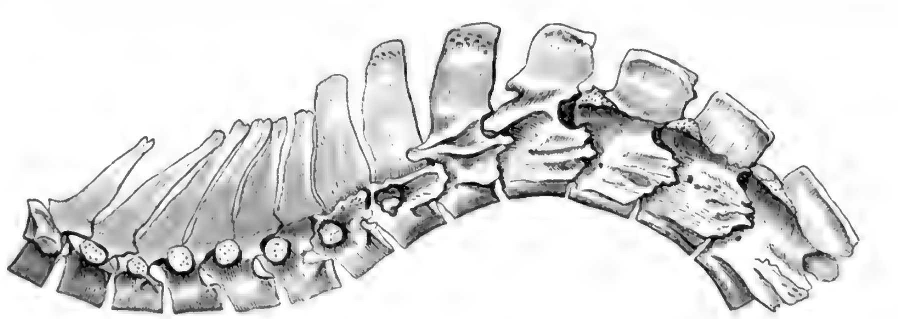


Fig. 14.—Dorsal Vertebræ.

The back can be greatly hunched up, and the root of the neck brought into line with the pelvis. The "centre of motion" is at the last three dorsals and first lumbar, as shown by the verticality of the spines of these vertebræ. The spines of the several anterior dorsals are much inclined backward, in order to allow the abrupt upward curve of the cervicals in the usual position of the body. Great length of spine is necessary in these vertebræ, to allow of advantageous attachment of the muscles situated in the concavity of the S. The occasion for the great expansion of the transverse process of the sixth cervical is seen when the neck-bones are placed *in situ* with the dorsals. This cervical is at the point of greatest convexity of the S; its processes form prominent *points d'appui* for muscles upon the anterior aspect of the spinal column.

As I have said, the transition from the cervical to the dorsal series of vertebræ is abrupt, and this occurs, both from the configuration of the two contiguous bones themselves, and the direction of the two series of bones. The large cervical spinous processes almost disappear with the last of that series, to suddenly reappear upon the first dorsal, but with different shape. The spine of the first dorsal is a long, slender, tapering process, directed a little obliquely backward; but in spite of this backward direction, so sharp is the angle between the neck and back, that the spine, in some attitudes, may reach forward so that its apex almost touches that of the fifth cervical—overreaching the sixth, and more especially the seventh cervical. The dorsal spines increase in length and obliquity of direction to the third vertebra, after which they begin to shorten and to stand more upright. The occasion for their greatly attenuated form is found in the fact that they project into the cavity of the sigmoid curve that the back here makes, and must therefore be capable of being packed in less space, else this concavity would not be attainable. Their slender spinous figure is preserved to the sixth, where they begin to thicken, and have, on this and two or three succeeding vertebræ, somewhat the massive pillar-like figure of those of the middle cervicals. They are thickened, widened and shortened on succeeding vertebræ, until the last has little or nothing to distinguish it from a lumbar spine. In this and in all other features the last dorsal is so much like the first lumbar that its being costiferous is almost its sole peculiarity.

The transverse process of the first dorsal is like that of the last cervical, but much stouter, and bears upon its apex a very distinct facet for the rib. This process grows shorter with successive vertebræ, and only retains the same general physical character as far as the eighth, beyond which it begins to be subjected to the modification of form that culminates in the lumbar series. There is a corresponding modification in the vertebral extremity of the ribs, which no longer articulate with the spine by their "tubercles"; in fact it is hardly possible to recognize "head, neck and tubercle," on ribs behind the eighth pair. As will be seen presently, the transverse processes of the lumbar vertebræ are expanded and mutually overlapping, almost exactly as in the cervical series. Something of this obliquity and longitudinal expansion is the modification that the transverse processes of the five posterior dorsals undergo; but the development is not sufficient to produce decided overlapping. Coincidently with this modification of the diapophysial elements, metapophyses began to be developed, increase in size to the last dorsal, and thence continue into the lumbar region. The articulations of the anterior dorsal lie directly in the axis of the spine, the articular facets of the pre-zygapophyses looking upward, and those of the post-zygapophyses downward. With succeeding vertebræ, obliquity, both in a transverse and a longitudinal direction, begins, and increases to the last. With the cessation of the articular "tubercles" for the ribs, the pre-zygapophyses begin to be surmounted by an elongated, pointed process, which grows less acute, and at the same time broader and heavier with succeeding vertebræ. The neural arches are low, broad, and comparatively thin, in the anterior portion of the dorsal series; they grow higher, longer, and more massive with each successive vertebra, and the same may be said, in general terms, of the centrums themselves. The intervertebral foramina are largest anteriorly; they progressively decrease in size from before backward, and at the same time gradually slide from the directly lateral position they occupy at first, more to the front of the column, so that they look forward as well as outward. The body of the first dorsal has one full costal facet, the others two demifacets, the rib being implanted on the intervertebral fibro-cartilage, and only nicking the edge of the bone itself. The bodies of the middle vertebræ are perfectly smooth on their thoracic aspects, and very convex from side to side; those at either extremity are slightly ridged by rudimentary hypapophyses.

Lumbar Vertebræ.—(Fig. 15.) The first lumbar repeats the characters of the last dorsal, and there is little modification in the remaining five bones of the series. The fourth vertebra, counting from before backward, is the largest of the set; the bones diminish in size in both directions from this one. The flexibility of this part of the spine is considerable in every direction; the movement of extension beyond a right line is least; that of flexion greatest. Few animals, indeed, except man, can make the "small of the back" concave. The zygapophyses bear nearly vertical articulating facets; the post- are locked within the pre-zygapophyses. The two processes are on either side connected by an acute, longitudinal ridge, which divides the side of the column into a narrow, deep sulcus above, between itself and the spinous processes, and a rather broad, shallow groove between itself and the series of transverse processes; these grooves are filled by the two divisions of the muscles of the loins. As already hinted, the transverse processes are greatly expanded lengthwise, in a slightly oblique direction, and mutually overlap each other like those of the neck. They increase in size and obliquity from first to last. The spines of the vertebræ are lowest and thickest at the first; they grow longer, higher, and thinner to the fifth; this and the sixth retain the height and thinness of the spine, but the length diminishes. The bodies of these vertebræ are, upon their ventral aspects, very convex transversely, and moderately concave lengthwise. The massiveness of the lumbar vertebræ, and the extent of their several processes, correspond with the great size and strength of the lumbar muscles, whose power must be sufficient, with the aid of the abdominal muscles, to enable the animal to flex the body to regain an ordinary position when suspended by the tail. Origins of caudal muscles, moreover, can be traced past the sacrum into this region of the spine, in which is their initial force.

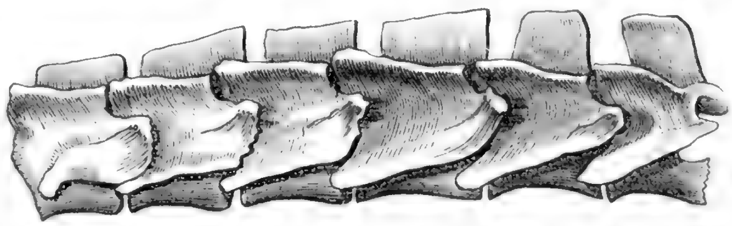


Fig. 15.—Lumbar Vertebræ.

Sacral Vertebræ.—(Fig. 16.) If the iliac synchondrosis be held to define the sacrum, this is composed of two bones; if serial anchylosis be taken as a guide, there are three sacral vertebræ. In adult animals, the equivocal bone is firmly united to the one preceding; but, at the same time, its physical characters are those of several succeeding coccygeals — as one of which it may be best to consider it. The chief modification of lumbar characters that the two sacrals undergo is exhibited in their transverse processes, which thicken in every direction, and become confluent, leaving only a moderately large circular foramen at the base of their line of union. While the expanded and elongated transverse process of the last lumbar points obliquely downward-forward, and upward-backward, the reverse is the case with the similarly expanded and oblique, though thickened, sacral diapophyses. This change is necessary for coaptation of the osseous surface with the obliquely placed iliac shaft. The synchondrosial surface borne upon the confluent diapophyses is irregular in shape, somewhat approaching a narrow semilune. Union with the ilia is very imperfect; so slight is the force required to detach the sacrum, that some care is requisite in making a dried preparation of the pelvis. This loose-jointedness is of a part with that at the symphysis *menti et pubis*, among many of the cranial bones, the several sternebers, etc.; and is, in fact, one of the characteristics of the animal's skeleton. The spinous processes of the sacrals remain distinct from each other; they have the same shape as those of the last two lumbars, and incline slightly forward. Zygapophyses are perfectly developed on both of the bones, but they only subserve movable articulation with the last lumbar, in consequence of the anchylosis of the two sacrals, and of the last of these with the first caudal. The motion of the last lumbar upon the sacrum is quite free.

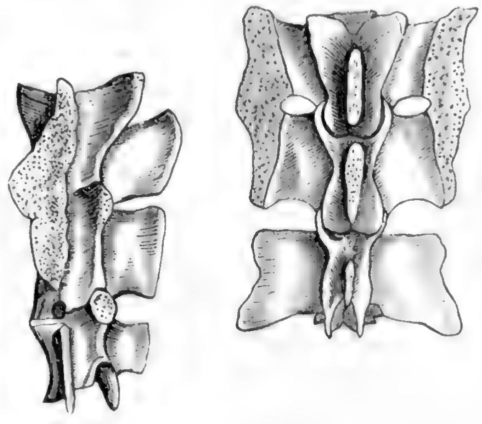
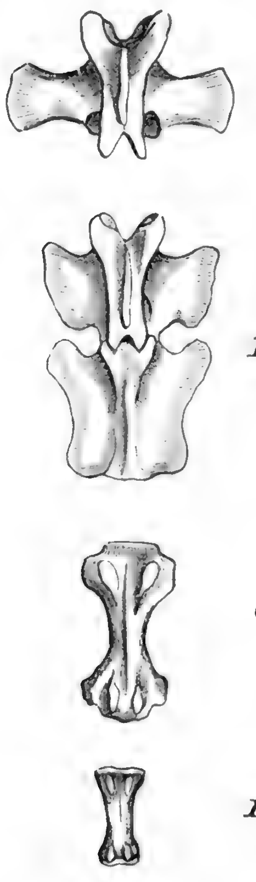


Fig. 16.—Upper and side views of Sacrum and first Coccygeal.

Caudal Vertebræ.—(Fig. 17.) Admitting the above mentioned questionable vertebra to this series, the tail is composed of twenty-three bones.[1] The adaptation of these bones to the prehensility of the member results in some interesting modifications. The first, as we have seen, is (always?) anchylosed with the sacrum; the remainder are freely movable, yet most of them — all beyond the fifth — have a different articulation, in which zygapophyses take no part. The series of articular surfaces is so arranged that the tail, when not in use, habitually assumes the shape of a note of interrogation laid horizontally, thus, ∽-, as may be shown by boiling the bones from which the skin and muscles have been dissected, and allowing them to dry, suspended in the air by their proximal extremity. Part of the curling under of the tail in life is, however, due to traction of the flexor tendons. Near the root of the tail some downward convexity is possible; elsewhere, the member cannot be extended beyond a straight line without forcible bending. Lateral bending is everywhere more or less free; and particularly so towards the root of the tail; so that when the animal is squatting, the tail can be



A

B

C

D

Fig. 17.
Coccygeal vertebræ: A, 2d;[2] B, 5th and 6th; C, 12th; D, 18th.

[1] Owen (Comp. Anat. and Phys., II, p. 332), says "twenty-two." The same author assigns to another species of the genus—*D. cancrivora*—thirty-one. In this, therefore, as in other genera of long-tailed marsupials, the number of caudal vertebræ varies within wide limits among the different species; and in the same species a difference of one or two bones may possibly occur, as an individual peculiarity.

[2] First unanchylosed one.

curled around the fore paws. Considerable twisting, or rotation of the vertebræ upon each other, can be borne without inconvenience. The perfection of the "fifth hand" is brought to mind as forcibly by its bones, as by the admirably adapted set of muscles, the closely packed bundles of tendons, and their dense fascial and cutaneous envelopes.

The first caudal is nearly a repetition of the last sacral, except as to its transverse processes. These resume the thin, expanded, laminar character of those of the lumbars; but increase in lateral projection or length, and are horizontal, not oblique. The spinous process suffers marked diminution both in height and length; the pre-zygapophyses are anchylosed; the posterior ones, though small, bear perfect articulating facets. The under surface of the centrum is concave lengthwise.

The next four (second—fifth) caudals are similar to each other, and have the following characteristics: The spinous process becomes rudimentary with the first of them (second coccygeal), and disappears with the last (fifth coccygeal). The transverse are broad, long, thin plates, of a squarish shape, slightly constricted at the base; they call to mind the corresponding process of the atlas; their longitudinal extent or width increases, from before backward, coincidently with a decrease of lateral projection; that of the second coccygeal is longest and narrowest. The anterior articular are long, conical, flaring processes, completely embracing the post-zygapophyses; both bear perfect facets. The neural arches are very short, and already have greatly diminished the calibre of the neural canal. The centrums are long for their breadth; the disparity increases from before backward with successive vertebræ, at the same time that their under surfaces become more and more flattened.

The degradation of the vertebræ, already apparent, is suddenly increased, and becomes very obvious, by the modification of the sixth caudal, which is the first to decidedly assume the physical characters that are to characterize the rest. Its transverse process changes to a thin lamina, running the whole length of the bone, wider anteriorly than behind; the body itself of the vertebra appears as if it were merely a longitudinal thickening of this lamina along the median line. Anterior articulating processes are perfect, as hitherto, in the caudal series; but post-zygapophyses have become rudimentary, and articulation with the seventh is effected only by the centrum. The rudimentary neural spine is only indicated by a thin, low crest along the middle line. Neurapophyses, however, have not entirely subsided, so that this vertebra is still perforate; but the canal barely admits the passage of a bristle, and appears not to transmit a continuation of the neural axis. The neural canal of the fifth terminates at the distal extremity of the bone in a somewhat different manner from that observed in antecedent vertebræ; the neural arch, leaving the articulating processes, extending upward, and flaring outward, is separated by a deep fissure from the centrum along the posterior third of the vertebra, so that the canal has a lateral as well as a terminal opening. The seventh caudal is impervious, and in other respects completes the changes that began with the sixth; and successive ones are no longer, teleologically, vertebræ, but simply the phalanges of the opossum's fifth hand.

The remaining caudals resemble phalangeal internodes, both in appearance and function. The next succeeding half dozen are longer, both absolutely and relatively to their width, than any of the preceding ones; but they gradually shorten, and more rapidly become attenuated. The transverse processes appear as a ridge on either side of the seventh—tenth, suffering constriction at the middle, so that the bones, viewed from above, present an hour-glass contraction. On the remaining vertebræ, these processes are simply little lateral knobs, representing, on the sides of the bones, the rudimentary zygapophyses on top. From about the seventh or eighth, they take part in the articulation. Rudiments of both articular and transverse processes may be traced to the very last bone; but they are very insignificant in size beyond the fifteenth or sixteenth, and articulation is really effected, beyond the sixth vertebra, by the ends of the centrums themselves.

In this scansorial prehensile-tailed marsupial, as in the saltatorial forms of the orders, the remarkable feature of "hæmal arches" is found. The use of these singular arches is, beyond a doubt, the protection of the blood vessels from undue pressure. They only occur in those species in which locomotion is aided by the tail, as the kangaroo, phalangers and opossums. In the present species these arches begin between the third and fourth caudals and continue uninterrupted to the very last. These chevrons are perfect throughout the series—not presenting the separation of the lateral moieties that occurs with the terminal ones in some other genera. They are V-shaped, and situated directly at the articulation; the proximal ones are the largest, in general, and the rest successively diminish to the last; but the second one is larger than the first, and the only one that presents a large hæmal spine, directed backward. The first half-dozen or so have decided spines in the direction of the arches; the rest no more protuberance than necessarily results from the coalescence of the two crura of the arch. From first to last all are perforate, and transmit vessels. Beside defending the circulation, they give leverage to the powerful flexor muscles of the tail. The ingenious device of these hæmal arches affords a beautiful illustration of exceptional development to meet special emergency.

3. The Thorax.

The dorsal vertebræ having been already considered, it only remains to notice, in this connection, the ribs and sternum (fig. 18).

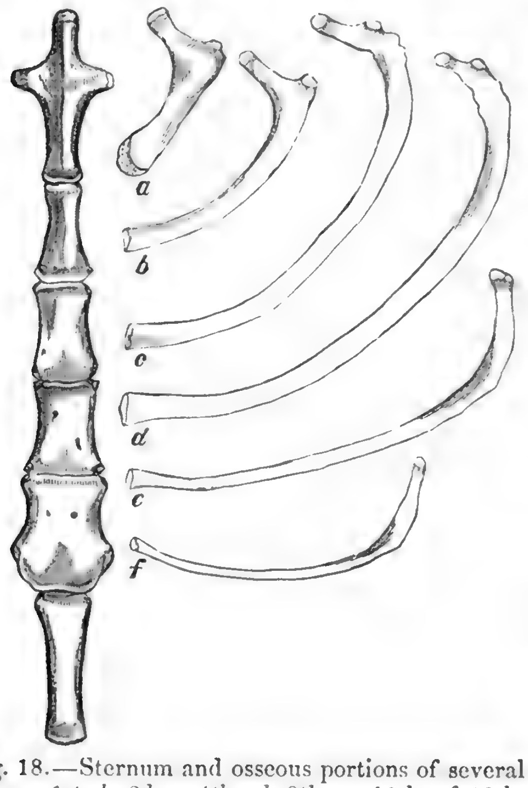


Fig. 18.—Sternum and osseous portions of several ribs; *a*, 1st; *b*, 2d; *c*, 4th; *d*, 8th; *e*, 11th; *f*, 13th.

There are thirteen ribs, six of which join the sternum, and three each other, leaving four free. The pleurapophyses alone are osseous; the hæmapophyses remain cartilaginous, or at most, had acquired but little bone-earth (and that only in the upper ribs) in the oldest individuals I dissected. The first pleurapophysis is very short—less than an inch long in well grown specimens—owing to the great contraction of the apex of the thorax; very stout, nearly straight, with a large tubercle, that appears as the real end of the bone, the neck being short and slender, set off at nearly a right angle from the main shaft, and bearing a slightly enlarged head. The ribs rapidly lengthen (*e.g.*, the third is more than twice as long as the first) to the sixth, seventh and eighth, which are about equal to each other, and longest; and then more gradually shorten to the last. Coincidently with increase of length, the curve of the shaft becomes greater, as does also the twisting of the shaft upon its axis. The curve and twist are both greatest at the sixth—eighth bones; whence they diminish in both directions with successive ribs. The difference in the direction of the axes of the neck and shaft of a rib decreases from the first to the last; and, *pari passu*, the distinction between shaft and neck becomes less and less, till it is scarcely recognizable on the eleventh—thirteenth. The tubercle, very prominent upon the upper ribs, vanishes before the last is reached. The tubercles do not bear perfect articulating facets beyond the ninth, the following ribs only jointing with the vertebræ by their heads; and the fifth—ninth ribs bear the second facet upon their neck, rather than at the most prominent point of the tubercle. The intercostal artery only distinctly grooves three or four of the longest ribs. The sternal extremity of the first rib is a stout knob; that of each of the others is flattened and expanded—most so with the longest bones.

The sternum is composed of six pieces, the general shape of which is shown in the accompanying figure. The lowest piece is thin and narrow, almost linear, with a slightly enlarged base for articulation with the fifth; it is supplemented by an extremely large, broad, flat, "xiphoid" cartilage, with a rounded free border. The fifth is subquadrate, nearly as broad as long, and abruptly thicker and stouter than the sixth. The next three are successively narrowed and elongated; the fourth and third preserving their squarish shape, and remaining flattened; but the second, with a depressed lower part, is rapidly narrowed and compressed above, to fit it to the manubrium. The latter is cruciform, being sub-cylindrical below, widening on either side to bear the arms of the cross, and developing from its outer or under surface a median longitudinal crest, that is further prolonged above the cross-pieces to form an elongated process. The clavicles are loosely joined to the apex of this process through the intermedium of oval cartilages; the heads of the cross-pieces bear facets for the articulation of the first ribs; the other ribs articulate at the sternebral interspaces; each sterneber bearing at both ends a demi-facet for this purpose.

4. The Anterior Extremity.

Observations upon the general characteristics of the fore limb will be found elsewhere. There are forty-four bones in the scapular arch and its appendage, twelve of which are sesamoid.

Scapula.—(Fig. 19, *A*, *B*.) The general shape is quadrilateral, with three corners rounded off, and the fourth produced to support the glenoid fossa and coracoid process; the accompanying figure shows the details of contour. The posterior edge is thickened for muscular attachment; the upper and under borders are thin. The thoracic surface, without concavity, is smooth and slightly undulating. The outer surface is likewise smooth and flat, or with slight

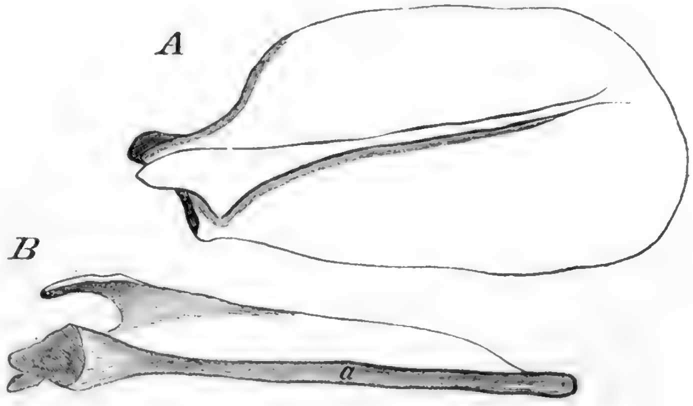


Fig. 19.—Scapula, from above and in profile.

concavity. The neck is short and wide; above, its margin is concave; below, straight, and in direct continuation of the lower border of the bone. The glenoid is an oval, somewhat elongated above, moderately concave in all directions, looking forward in the plane of the bone, and obliquely downward. It terminates above as a roughened tubercle, for attachment of the biceps; a slight notch separates this prominence from the coracoid. The latter is only a small knob, scarcely projecting beyond the margin of the glenoid, and bent obliquely or diagonally from the postero-superior angle to the antero-inferior, and terminating at the neck; the supra- and infra-spinal fossæ are of nearly the same superficial extent. The spine is perpendicular to the plane of the bone, rises higher and higher as it advances, and terminates in a large, flat, horizontally expanded, triangular acromion that projects over the glenoid, and is separated from the latter by a wide and deep notch.

Clavicle.—(Fig. 20.) The collar-bone is small and simple, with a single curvature, flattened, and slightly twisted upon its axis. Both extremities are slightly knobbed. Its acromial connection is very loose, and it has no true articulation with the sternum, being bound to the latter by long ligaments, in which a small oval cartilage is obliquely placed; this cartilage scarcely being of that sort usually denominated "interarticular."

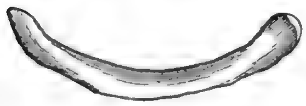


Fig. 20.—Clavicle.

Humerus.—(Fig. 21.) The humerus is stout, of moderate length, and with one general curve forward. The most highly developed of its several well marked ridges, is that forming the outer border of the bicipital groove; it is sharp, extends more than half-way down the bone, and ends in a large, roughened tubercle for the deltoid. The groove itself is shallow, from lack of a well marked inner ridge, except above, where it forms a decided depression between the inner and outer tuberosities. The last of these is much the larger of the two, and is continuous with the deltoid ridge; but both are well defined. There is no proper "neck;" the shaft gradually thickens above as it curves inward to support a large and very convex head; the articular surface looks in the usual direction; its contour is somewhat triangular, the three corners corresponding to the two tuberosities and a backward prolongation. The condyles and their ridges differ from each other in size and shape; the outer is shorter and broader, runs up with a sharp border, which abruptly subsides to give place to a smooth, rounded surface; but a musculo-spiral groove is scarcely recognizable; the inner condyle is longer and narrower, with a straight, oblique, smooth, thickened border that bridges over the large oval foramen (*g*). The expanded intercondylar space is smooth and flat; its anterior surface presents a radial depression, but no decided coronoid fossa; posteriorly there is a well marked olecranoid cavity. The extremities of the condyles are thick and rough for muscular attachments. The lower extremity of the bone curves a little forward, and the articular surfaces look in this direction as well as downward. These present no special peculiarities; they are continuous with each other; both are convex in every direction; the ulnar reaches lower than the other, and terminates

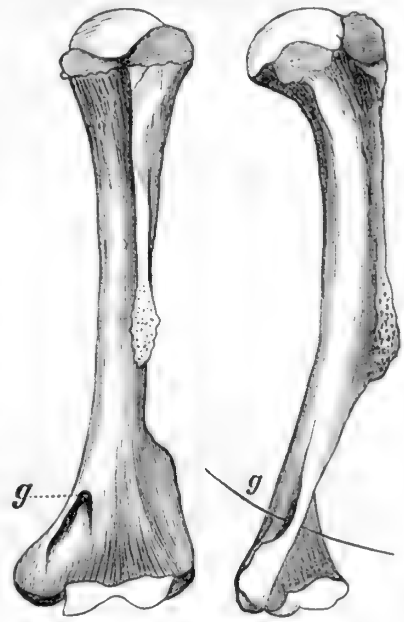


Fig. 21.—Left Humerus.

abruptly externally, instead of gradually subsiding. Certain minor differences aside, the resemblance of this bone to the human humerus is striking.

Ulna.—(Fig. 22.) Considerably longer than the radius, in consequence of the great backward prolongation of the olecranon and length of the conical lower extremity. The olecranon lies in the axis of the shaft so that the articular cavity appears cut out from the upper aspect of the latter. Below, the shaft is nearly straight and cylindrical; its upper half is much compressed, the posterior border presenting itself as a curved ridge; and the anterior aspect has also a slight ridge along its middle third, subsiding above into a smooth, oblique, depressed face, along which the radius lies in pronation. This space widens internally, and suddenly curves forward to form the anterior lip of the greater articular cavity; externally it expands still more, and runs out into a pointed eminence, forming the floor of the "lesser sigmoid cavity," in which the head of the radius rests. The two articular cavities are continuous with each other; the greater lies very oblique to the axis of the shaft. The coronoid process is wider and more prominent than the posterior lip of the facet; which latter only represents a small part of the whole olecranon. The pointed, conical lower end of the bone is received, and rotates, in a cup-shaped depression, between the cuneiform and pisiform; the facet for the radial articulation is obscure. (The outline gives the profile of the sigmoid cavity.)

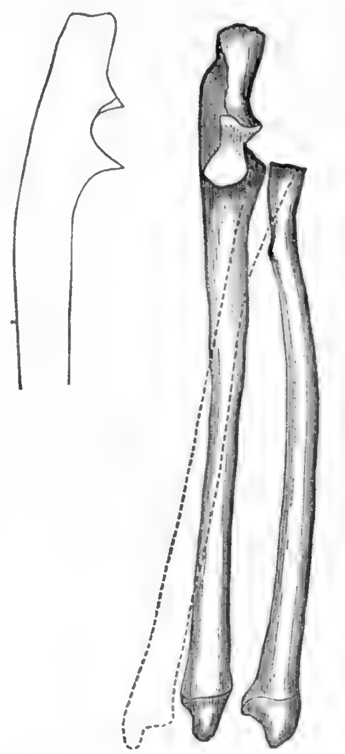


Fig. 22.—Left Ulna and Radius.

Radius.—(Fig. 22.) In the supine arm the radius lies very nearly parallel with the ulna; and the bones are only separated by a narrow interspace. The head of the bone presents the usual shallow circular cup for humeral articulation; continuous internally with a small convex facet that fits the lesser sigmoid cavity; rotation of the head, and, consequently, pronation of the arm, being perfect. The shaft is straight as far as the tubercle, where a gentle outward curvature begins, and thence continues to the lower extremity—enabling the bone to just clear the ulna during pronation. The stout enlarged lower extremity presents a broad, articular surface, that is prolonged, externally, into a conical process, like that of the ulna. This eminence overlies the scaphoid; the rest of the head articulates with the semilunar. (The dotted line indicates the radius in pronation.)

Carpus.—As in man, there are eight carpal bones, four in the proximal and four in the distal row; there are also two sesamoids on the radial side; the distal one of which articulates so extensively with the trapezium that it might be regarded as a fifth carpal bone proper of the second row. This sesamoid is wedged in between the trapezium and scaphoid; the proximal sesamoid is much smaller; it is merely a flattened oval nodule, ligamentously connected with the scaphoid and end of the radius.

The *scaphoid* has a large, flat, oblique facet for the radius, a cupped one for the semilunar, separated from a smaller, irregular facet for the trapezoid by a sharp process that extends between the semilunar and trapezoid nearly to the magnum. The relation between the scaphoid and trapezium is less intimate than that between it and the other bones just mentioned. The *semilunar* is a small concavo-convex triangle, with two facets upon its convexity for the radius and scaphoid respectively, and one upon its concavity for the spur of the unciform; its distal border touches the magnum; its proximal border the cuneiform. It is thus in relation with five bones, as in the human hand. The *cuneiform* is wedged between the ulna, semilunar, unciform and pisiform; its ulnar facet is large and concave; that for the unciform next largest and concavo-convex; that for the pisiform plane, and continuous with the ulnar one. It merely touches the semilunar. The *pisiform* is the largest bone of this row, having a produced and knobbed free extremity, and looking, in fact, like an aborted metacarpal. Of its two facets, the large flat one is for the cuneiform; the smaller concave one combines with a similar one on the cuneiform to make a depression for the ulna. Its knob affords attachment and leverage to the *flexor carpi ulnaris*, and some muscles proper to the hand. The *trapezium* is very small, and irregularly triangular; it bears an oval depression for the head of the first metacarpal, a plano-concave facet for the trapezoid, and a little smooth surface for the distal sesamoid. It is scarcely to be called properly articulated with the scaphoid. The *trapezoid* is still smaller; its metacarpal facet only receives part of the head of the second metacarpal, which reaches the trapezium on one side, and the *os magnum* on the other; the bone articulates with the magnum, trapezium and scaphoid, but is excluded by the pointed process of the latter from the semilunar. The *magnum* is larger than either of the last two, but nevertheless smaller than the unciform; the metacarpal facet is divided by a sharp, vertical ridge into two parts, one supporting part of the head of the second metacarpal, and the other the whole of the head of the third metacarpal. The bone has an elongated facet for the unciform, a small convexity for the semilunar, and an irregular surface for the trapezoid; it also appears to touch the process of the scaphoid, and the side of the head of the fourth metacarpal. The *unciform* is the largest bone of the wrist, and supports the two outer metacarpals upon one facet, divided by a barely appreciable ridge; it is singularly irregular in contour, having a large hooked process that curves under the base of the fifth metacarpal, and a similar, but smaller and straighter prolongation between the cuneiform and magnum.

These ten bones together form a much arched wrist, concave in front from side to side, and correspondingly convex across the anconal aspect. The deep groove along the palmar surface is filled by the flexor tendons. The bones are very closely packed and interlocked; almost the only irregularity of superficies is that caused by the knob of the pisiform and hook of the unciform. The composition of the wrist is strikingly like that of man; the two sesamoids aside, there is really little difference to be noted, although none of the bones have precisely the same shape and mutual relation. The sinking of the ulna into the depression common to the cuneiform and pisiform, the exclusion of the trapezoid from contact with the semilunar, and the size and shape of the unciform and pisiform are among the chief differences displayed. The unciform and magnum appear to change places as regards the extent of metacarpal support they furnish, the former having here the largest articulating surface.

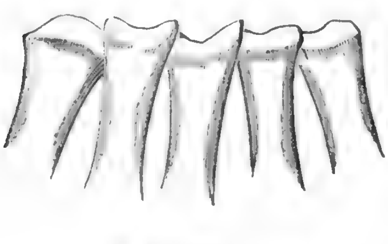


Fig. 23.
Heads of Metacarpals enlarged.

Metacarpus.—The five metacarpals are all of different lengths—the middle one being the longest, the second and fourth successively a little shorter, and the fifth much less than the fourth, which only slightly exceeds the first—the latter being the shortest. The four finger metacarpals are notable for the enlargement of the heads, as compared with the bases; the slenderest point is just beyond the base, whence the bone gradually enlarges to the clubbed extremity. The thumb metacarpal differs in being larger at the base than at the head, and in having the constriction nearer the distal extremity. The second—fourth metacarpals lie as nearly parallel to each other as the difference in the size of their bases and heads will permit; these are both in contact, the former by articulation, the latter by simple apposition. The first, on the contrary, stands away from the others at an open angle; and this divergence is indicated as clearly by the articulating facet upon the side of the base of the bone, as by the outward shape of the hand. The facet in question is small and slightly cupped, and situated in a plane only a little oblique instead of perpendicular to, and directly continuous with, that for the carpal articulation—that is, upon the top of the head of the bone, rather than upon the side. It fits a little protuberance upon the corner of the base of the second metacarpal, and has motion in more than one direction, much freer than that enjoyed by the others. The head of the second metacarpal is divided by a vertical groove into two parts, with rather sharp and somewhat produced edges, one of which bears the facet for the first metacarpal just noticed; the other projects over the base of the third, so that the latter has carpal articulation only by half its head, the other half being received into a depression in the side of the head of the second. The head of the fourth, slightly convex and scarcely grooved, is flush with the corresponding half of the head of the third; the two are mutually apposed by a small plane facet. The head of the fifth is again flush with that of the fourth; it is made somewhat triangular by a small pointed process on its distal side, separated superiorly by a decided groove from the rather convex facet by which it articulates with the fourth. All these inequalities of the heads of the bones as one row correspond, it need hardly be added, to irregularities in the surface of the contiguous carpal row. The metacarpals are depressed along their shafts, being wider than thick; they are straight, or nearly so, but downward production of both bases and heads render their palmar profile concave; which arching, together with the concavity of the hand from side to side, produces a decided palmar hollowing. The heads of all the bones are very convex, wider than deep, and present a slight median vertical ridge bounded on each side by a corresponding slight groove; these inequalities are most marked on the first.

Phalanges.—There is scarcely any difference in the lengths of the second—fourth; the claw of the fifth reaches the base of that of the fourth; the claw of the thumb only reaches to the base of the middle phalanx of the index finger. The fingers have each three phalanges, whereof the first makes up most of their length, equalling, or exceeding, the other two and the claw together. The thumb has two; the proximate one is as long as the distal one and its claw. The ungual phalanx of each finger and the thumb is simply a little nodule supporting the claw—the thumb, unlike the great toe, being unguiculate like the other digits. The other phalanges have the usual configuration, and present no noteworthy peculiarities.

Sesamoids.—There are ten sesamoids in the hand—two small oval nodules placed lengthwise, side by side, beneath the metacarpo-phalangeal articulation of each of the five digits.

5. The Posterior Extremity.

In each half of the pelvic arch and its appendages there are forty-six bones; they are arranged as follows:—pelvic, four; femoral, one; in the knee, two (counting the rudimentary patella); crural, two; tarsal, eight; metatarsal, five; phalangeal, fourteen; sesamoids of the foot, ten. The eighth tarsal is the ossicle supporting the small cartilaginous spur. The patella scarcely deserves to be included in the enumeration; it consists at best but of specks of ossification; the other bone of the knee is the fibular fabella, which, though called sesamoid, is distinctly articulated with the fibula.

Ossa innominata.—(Fig. 24.) Bony union of the ilium, ischium and pubis occurs late, traces of separation being still distinct in adult specimens. The pubis forms less of the acetabulum than either of the other two; the ischium contributes the most. (Fig. 24, outline.) The cotyle is ample, both in depth and breadth, having a conspicuously raised, sharp, bony border around about three-fourths of its circumference; the remaining part of its margin (ischiatic and anterior) is much lower, without a sharp ridge, rising gradually in front to meet the pubic ridge, separated posteriorly from the ischiatic ridge by a narrow but deep groove—the ischiatic ridge terminating abruptly, with almost a process overhanging this groove. In the recent state this depressed part of the acetabular rim is made up with ligamentous tissue. In mature individuals there is no distinct articular ossicle, or "epiphysis of the ilium" like that described by Owen as existing in the immature Potoroo (Comp. Anat. Vert., II, p. 357), nor a second similar ossicle at the ischio-pubic symphysis. The synosteosis of the three bones at the acetabulum appears uninterrupted. Some irregularity of superficies that is apparent at the ilio-pubic junction may indicate the existence of such ossicle in specimens younger than those examined. The floor of the acetabulum is frequently so thin as to be diaphanous.

Fig. 24—Right half of Pelvis.

The contour of the innominate bone may be best gathered from the figure, which is drawn in the plane of the expanded ischium. It is spatulate in general shape, with the long, straight ilium for the handle of the spoon. The ischiatic tuberosity is not produced much backward of the axis of the ilium, nor notably curved in any direction, though a little so outward; it is obtusely rounded, and little more thickened than the main plate of the bone. The posterior or "ascending" ramus of the ischium inclines a little obliquely inward toward the acetabulum; its stout posterior border forming a ridge which mounts behind the acetabular wall to be continuous with the ilium above; its outer face is rendered concave, by the uprising of the cotyloid brim. The lower border of the ischium offers a gentle, unbroken curve to the pubic symphysis. This border, and the pubic symphysis, are both of great length; their union is indicated by a slight prominence, above which the symphysis mounts in a nearly straight line. On the pubic ramus, just at the symphysis, lies the smooth, narrowly oval prominence for the articulation of the marsupial bone; between this and the cotyle the pubis is slenderer than elsewhere. The obturator foramen is large, and sub-circular in shape—its chief irregularity of contour being produced by an extension upward in front of the acetabulum. The ilium, after expanding to form its part of the acetabulum, narrows for a little, without decided ridges or borders, and then suddenly becomes sharply prismatic; which shape it preserves to its tip. The outer and posterior faces of the prism are perfectly smooth—the former decidedly concave: the inner (which is the broadest) is roughened in the usual manner for the sacro-iliac synchondrosis. The apex of the ilium is slightly clubbed, smooth and convex. The shaft is almost perfectly straight. With the exception of the sacral portion, the whole internal aspect of the innominate bone is smooth, and devoid of decided prominence. The two sides of the pelvis meet at the pubis, at an angle of less than 90°.

It is only necessary to allude, in this connection, to the great size of the pelvic outlet that obtains in this, as in other marsupials, compared with the dimensions of the fœtus at term. The disproportion is, however, less than that of some *Marsupialia salientia*; though greater than that which obtains in the Petaurists, where, according to Owen, the diameter of aperture is six times that of the fœtal head. Aside from other pelvic characters common to the order, (such as length, narrowness and flatness, extreme modification of ischio-sacral notch, extensive pubic symphysis, etc.) the length and straightness of the ilia, flatness of the ischia and pubes, and a general deficiency of well-marked angles or processes, such as an ilio-pubic or a backward, curved extension of the tuber ischii, are among the most notable points. The mammalian pelvis here finds very simple expression. The shape of the pelvis appears to relate mostly to the prehensile function of the tail, and the arm-like movements of the posterior extremities—to which latter it is peculiarly adapted.

Ossa marsupialia.—(Fig. 24.) The characteristic adjuncts of the marsupial pelvis here appear of moderate proportions, being neither very large nor very small, and of simple form. They are an inch and a quarter or half long, and ordinarily stand a little outward and forward, diverging from each other, their bases almost in mutual contact. In the accompanying figure, this obliquity would cause the bone to be much foreshortened were it drawn *in situ*; it is accordingly dislocated and laid flat in the plane of the rest of the pelvic wall. The shaft is flattened, smooth, without decided processes, very slightly curved (the convexity outward), slightly knobbed at the apex, spreading below into a laterally expanded foot. The margin of the base is oblique to the axis of the shaft, prolonged to meet its fellow at the symphysis pubis, and giving off externally a rounded knob or claw which lies upon, though not articulating with, the pubic ramus. The articulating facet is flat and narrowly oval, loosely fitting the tuberosity on the pubis already noticed. The joint is a simple hinge, permitting only flexion and extension of the bone upon the pubis; the amount of motion enjoyed is considerable. The mutual relation of the planes of the two articulating surfaces is such, that when the bones are drawn toward the abdomen their apices are approximated; and conversely.

The marsupial bones do not present any notable differences in the two sexes. In the male, they are thought to be subservient to the action of the cremaster, but as this muscle passes across them but little above their bases, the greatest outward inclination that they are capable of would but slightly affect the course, and consequently the traction, of this muscle. In the female, they must, I think, further the advantageous action upon the pouch of the muscles of the abdomen, even if they do not actually increase the power of the latter. Their relation to the proper muscle of the pouch may be more intimate and important.

They probably also tend to preserve the shape of the pouch, acting to this effect like the ribs of the thorax, though in far less degree. But their most important office is believed to be the increasing of the power or effect of the female cremaster, or "ilio-marsupialis," which muscle winds around them as around pulleys on its way from the haunch-bone to the mammary glands. Still this is only an assumption; for the strong suctorial power that the youngest animals have been found to possess, renders it improbable that voluntary muscular effort in compressing the glands on the part of the mother is called for. It seems highly improbable that they play any part in the act of parturition, as some have supposed. Owen regards them as homologically the hæmapophyses of the last lumbar vertebræ; and as teleologically belonging "to the category of the trochlear ossicles, commonly called sesamoids," being "developed in the tendon of the external oblique which forms the mesial pillar of the abdominal ring, as the patella is developed in the tendon of the *rectus femoris.*"

Femur.—(Fig. 25.) The thigh-bone is long—over three inches in length—perfectly straight, stout, and nearly cylindrical. There is no decided "linea aspera," the posterior surface of the shaft being, instead, somewhat flattened, and presenting at the junction of its middle and lower thirds a tuberosity —almost a "process," which is rough for attachment of the adductor magnus. The shaft is slenderest at its middle, whence it gradually enlarges to the condyles. These have a backward extension; anteriorly, the mesial groove for the rectus tendon is broad and very shallow[1]; posteriorly, a very deep notch separates the two articular surfaces. The condyles are of nearly the same size; the inner one is the longest, and has the most backward and inward production; the outer is shorter and broader, and with a sharper external border. The lateral aspects of both are prominent, and rough for ligamentous attachments. The inner articular surface is narrow, and transversely flat or slightly convex; the outer is broader, and a little concave in the same direction. The head of the bone is far to one side of the axis of the shaft, held obliquely upward and inward at an angle of 45° upon a short, stout neck. A transverse section of the head and neck together would be in the same plane as a similar section across the two condyles—there being no twisting of the head either forward or backward. The articular surface is almost a hemisphere; the well-marked depression for the *ligamentum teres* is situated near the inner margin of the hemisphere. The constriction of the neck is slight. A slight ridge upon the postero-internal aspect of the neck soon rises into the sharp, well-marked, triangular *trochanter minor*, and suddenly subsides. This trochanter is situated upon the back and inner aspect of the shaft, nearly in the same plane as the latter. A stout ridge crosses the neck behind, running

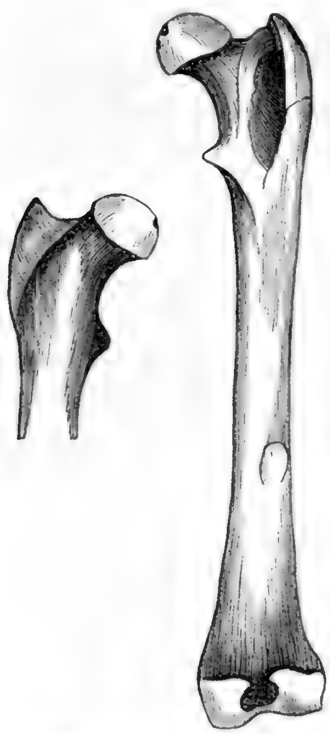


Fig. 25.—Right Femur.

[1] In consequence of (or causing?) the imperfection of the patella. According to Owen, "the intermediate anterior groove for the patella is well marked in the Perameles, where the patella is fully developed, but is broad and very shallow in the Phalangers and Dasyures, where the tendon of the rectus muscle is merely thickened, or offers a few irregular specks of ossification; and the corresponding surface on the Wombat and Koala is almost plane from side to side; in these marsupials and in the Myrmecobius the patella is wanting." The opossum is another instance of correspondence between this groove and the patella; exemplifying a law that perhaps has no exceptions.

obliquely upward and outward to connect the root of the small trochanter with the apex of the *trochanter major*. The latter is remarkably large and strong; its pointed apex rises fully as high as the top of the globular head, from which latter it is separated by a deep sulcus. The roughened surface of the trochanter to which muscles are attached, is of great extent, broad and obliquely truncated above, below gradually narrowing and losing itself in the shaft; but the downward continuation of this trochanteric line may be traced below the middle of the shaft, and chiefly gives the flattening of the posterior surface of the bone, already mentioned. Anteriorly, the expansion of bone between the trochanter and the neck is broad, smooth and nearly plane; posteriorly, the corresponding surface is interrupted by the inter-trochanteric ridge, and a remarkably large and deep "digital" fossa. The latter is of a narrowly oval shape, and is excavated to an unusual depth—being roofed over, as it were, by the backward expansion of the great trochanter.

The hip joint is well adapted to extensive and varied movements of the thigh—rotation, extension and abduction being specially favored, as usual with scansorial animals. The amount of motion permitted seems not very much less than that enjoyed by the shoulder joint, much of the mobility of the latter taking the place of the comparative stability with which a hip joint is usually endowed. This quasi-quadrumanous animal requires that the conditions of the proximal articulation of the fore and hind limbs should not be very dissimilar. At the hip joint we find beginnings of a series of modifications in the hind limb; which, constantly augmenting, culminate in the production of a member that is as much an arm as a leg.

Tibia.—(Fig. 26.) The fibula does not properly enter into the formation of the knee joint, the head of the tibia alone articulating directly with the femoral condyles. The articular surfaces present nothing specially noteworthy; the outer is decidedly the larger, and is a little convex in all directions; the inner presents a well-marked concave depression; the two are separated by an irregular prominence. The outer one presents, besides its femoral facet, a small, oval, transversely convex, smooth, articular surface, upon its outer margin, which is received into a corresponding concave facet upon the inner margin of the fibular head. This arrangement calls at once to mind the peculiar radio-ulnar articulation; and, in connection with certain peculiarities in the head of the fibula, to be presently noticed, has been used as an argument in favor of the homotypy of the ulna with the fibula and of the radius and with the tibia. But the tibia does not in this case rotate upon the fibula, but the reverse; and it is immaterial which bone bears the concave, and which the convex, facet. The "lesser sigmoid flexure" of the ulna here finds expression in a prominence instead of a depression; the concave lateral facet of the fibula is adapted to this prominence, as the convex lateral articulating surface of the radius fits the depression in the side of the ulnar head. The anterior tibial tuberosity (the "olecranon of the leg") is moderately prominent, and gradually subsides into the shaft of the bone. The latter is much compressed laterally; but its chief peculiarity is found in its bending along the middle of its course toward the fibula, as well represented in the cut. A "crest" may be traced along the whole length of the bone; but, contrary to the usual rule, it is sharper and more elevated below than above, owing to

Fig. 26.—Right Tibia and Fibula.

the gradual subsidence of the tibial tuberosity. The shaft, as a whole, is slender and weak, and presents no well defined sulci or ridges, except the crest just mentioned. The distal extremity enlarges gradually, and is extended into an obtuse conical process that forms the inner malleolus; the articular surface is very obliquely placed, irregularly triangular in contour, and nearly flat—its only concavity resulting from the downward extension of the malleolar prominence. While this malleolus is sufficiently produced to overlap and confine the corresponding side of the astragalus, the general configuration of the tibial articular surface insures great freedom of motion in the ankle joint.

Fibula.—(Fig. 26.) The distal extremity forms a perfect malleolus, as in other marsupials, and presents internally a facet for articulation with the tibia—this facet being continuous with that for the astragalus. Both the crural bones enter largely into the formation of the ankle-joint; and this distribution of the articulation of the astragalus between two bones, instead of its restriction mainly to one (the fibula), probably produces a great part of the whole difference in the relative degree of mobility enjoyed by the cruro-tarsal and radio-carpal articulations. Still the restriction of motion is not great; and the foot enjoys rotatory movements perhaps more than merely analogous to the pronation and supination of the hand. When the foot is strongly extended— and it can be extended till its longitudinal axis is directly continuous with that of the leg,—its movements of rotation are virtually, if not actually, those of pronation and supination. Did the tibia take but little less part in the formation of the ankle joint, it would become merely the pivot upon which the foot, borne upon the fibula, would rotate, and would exactly conform the conditions of the ankle to those of the wrist. The shaft of the fibula is very slender, almost perfectly cylindrical, and quite straight. The groove for the passage of the tendons of the peroneal muscles is but slightly marked, and scarcely traceable above the malleolus. At the upper end of the middle third the shaft begins to flatten and expand laterally to support a remarkably enlarged head. This expanded surface is posteriorly flat and smooth. Anteriorly it is transversely concave, and somewhat roughened for the attachment of the large peronei. The head of the bone is partially divided into two tuberosities, both irregular in contour. The inner one, which is the smallest, bears the oblique, concave facet already noticed. To the outer is attached a large "sesamoid" bone, to be more particularly described in speaking of the knee joint. The shaft of the fibula is not in contact with that of the tibia in any part of its length; both the proximal and distal extremities of the bone have, as we have already seen, loose articulation with the tibia. The decided inclination of the tibial shaft toward that of the fibula may relate in some way to the forearm-like movements of the leg; but it is not easy to see how these are favored by this means.

Knee joint.—The general mutual relations of the two bones of the leg are well calculated to increase mobility at the expense of stability; carrying out a purpose that began to be apparent in the structure of the coxo-femoral articulation. The resulting conditions are the opposite of those presented by the saltatorial marsupial genera, in which the tibia and fibula are united, or closely coaptated. The structure of the knee joint evidences the same plan, by allowing of other than strictly ginglymoid movement. Although this articulation is, as usual, femoro-tibial only — the fibula having no actual contact with the femur — yet the expanded fibular head, and the presence of the fibular fabella, contribute in some measure to femoro-fibular relations and movements that correspond to those existing between the humerus and radius. Whether as cause or effect of the shallow anterior intercondylar groove of the femur, the patella is deficient, as in many other marsupials that have similarly constructed femoral condyles. In most instances, there is barely an indication of a patella in a slight, apparently cartilaginous, thickening of the extensor tendon; in some there is absolutely no trace of such a bone; in old subjects, one or several small specks of ossification, seeming to the touch like gritty particles, may be demonstrated. In this animal, at least, there is no "olecranon of the leg," detached or otherwise, unless such process is represented by the "tuberosity of the tibia." The most noticeable feature of the knee joint is found in the presence of the fabella, developed in the outer lateral ligaments. This is an osseous nodule of an oval shape, with an enlarged base, surmounting the most external and posterior corner of the head of the fibula. It has a real articulation with the latter, a smooth, plane facet, subcircular in outline, being plainly shown upon the opposed surface of each bone. The presence of this ossicle may relate in some way to the rotatory movements of the leg; more obvious purposes subserved are strengthening and defending of the joint, and affording part of the attachment of origin of gastrocnemial and peroneal muscles.

Tarsus.—(Fig. 27.) The seven bones of the tarsus proper conform very closely, in individual characters and general disposition, to those of the human foot. The locking of the head of the second metatarsal between the two lateral cuneiforms obtains. Among the more prominent differences are, the shape of the articular surface of the astragalus, permitting freer motion at the ankle; the shape of the ento-cuneiform, producing the divergence and open articulation of the hallux; and the presence of the ossicle, attached to the ento-cuneiform, for the support of the rudimentary spur.

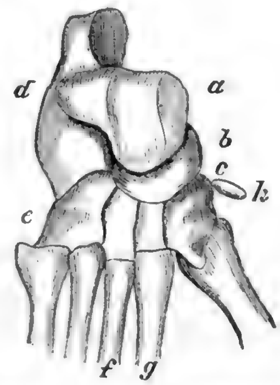


Fig. 27.—Tarsus and heads of metatarsals, 1 1-2 natural size.

The *astragalus* (fig. 27, *a*) is depressed, and of an irregularly triangular shape. The superior articulating surface — convex in every direction — receives the impress of both tibia and fibula. Along the middle is a slight antero-posterior groove, limited on either side by a slight ridge. This groove receives the head of the tibia, the internal malleolus resting against an oblique articular surface on the inner side of the groove; and the external malleolus resting upon a similar, though shorter and more convex, articular surface on the opposite side of the groove. The planes of these two lateral articular facets are but few degrees oblique to that of the median one; instead of being, as in many mammals, nearly perpendicular. As a whole, the large convex articular surface calls to mind that formed by the proximal row of carpal bones; and allows the same kind, and nearly the same degree, of motion that exists in the wrist. The posterior border of the astragalus is nearly straight; the internal one much curved; the antero-external one deeply excavated. The lengthened outer corner overlies and rests upon the calcaneum, near the middle of the latter; the anterior corner also rests in part upon the same bone, and extends to the cuboids, but is mostly received in, and presses upon, the navicular, transmitting pressure to the cuneiforms. The posterior corner projects freely backward and dips downward, to complete, with the os calcis, the groove for the passage of tendons behind the heel to the sole. The under surface is very irregular; there is a slight cupping for reception of a calcaneal protuberance, a decided convexity that fits a corresponding depression in the os calcis, and finally a prominent ridge opposing the concavity of the navicular.

The *os calcis* (fig. 27, *d*) is very large and stout. It projects far back, terminating in a roughened knob for attachment of the tendo Achillis. Upon the plantar surface a prominent, stout, straight ridge runs along the median line from the posterior extremity. This ridge, with the help of a process from the astragalus, defines the groove for the digital flexor tendons, and divides the plantar surface of the bone into two large, smooth faces, rising obliquely on either side and spreading, or flaring, to support the expanded rotular aspect of the bone. The latter is very irregular, both in contour and superficies. It presents a prominent tubercle, which fits a facet on the under surface of the astragalus, and, more internally, a depression corresponding to an elevation on the astragalus. Anteriorly, the bone articulates with the cuboid alone (not with the navicular), by an oblique depressed surface.

In general terms the *navicular* (fig. 27, *b*) may be called hemispherical; but its contour is irregular, being moulded by surrounding bones. There is a deep depression behind and above for the astragalus, and a small, oval facet externally for the cuboid. The three cuneiforms are supported upon a continuous surface—the facet for the internal one being most distinct and decidedly convex; while the whole surface is convex from side to side. The internal and inferior non-articular surfaces are roughened for the attachment of ligaments.

The most noticeable feature of the *cuboid* (fig. 27, *e*) is the very deep, transverse groove that lodges the tendon of the peroneus longus. There is a deep pit upon the inner face of the bone, just in front of the facet for the navicular. The upper surface is nearly plane. Besides the convexity behind for the articulation with the calcis, the cuboid sends a sharp process to meet the plantar ridge of this bone. As usual, the bone supports the two outer metatarsals. The facets are scarcely separated by a ridge; that for the fourth metatarsal is the longest and most cupped; the other has a slight process overlying the base of the fifth metatarsal.

Of the three *cuneiforms*, the outer (fig. 27, *f*) and middle (fig. 27, *g*) deserve the name "wedge-shaped," being driven in and locked between the cuboid, inner cuneiform, navicular, and third and second metatarsals. The anterior face of the ecto-cuneiform is not flush, either with that of the cuboid or of the meso-cuneiform, but projects forward. The meso-cuneiform is the shortest and smallest of the three; it and the ecto-cuneiform both bear simple facets for the corresponding metatarsals.

The *ento-cuneiform* (fig. 27, *c*) is different from the other two, being noticeable for the acute process that assimilates it in physical character to the unciform of the wrist. The bone is of a very irregular shape, difficult of description, but may be said to have a thickened base, by which it articulates largely with the navicular and meso-cuneiform, and from which a stout, curved process is sent forward to overlie the base of the first metatarsal. The articulating surface for the latter is narrowly elongate, concavo-convex, with a strong ridge and deep sulcus, reciprocal to inequalities on the head of the metatarsal. The plane of this facet is turned away from the common plane of the others, its degree of obliquity expressing the divergence of the great toe from the rest. While the other tarso-metatarsal articulations are close, allowing little mobility, and that chiefly in one direction, this one is almost as free as a metatarso-phalangeal joint, in the line of flexion and extension, and enjoys, moreover, considerable motion in other directions.

Besides these seven bones, there is an *accessory ossicle* (fig. 27, *h*) for the support of the rudimentary spur. It is a small conoidal bone, with an oval base, by which it is articulated with the inner aspect of the ento-cuneiform. It enjoys little, if any, motion. The spur is a small, oval, concavo-convex cartilage, lying closely appressed upon the muscle, over the base of the ball of the great toe, and covered by the common integument. Its position is indicated in the sole by the most internal of the tegumentary callosities. It is chiefly interesting as an indication of the well developed spur of one sex of the only lower mammalian order — the Monotremata. In the opossum the spur is not characteristic of sex.

Metatarsus.—The metatarsals are nearly straight, but a slight downward projection of the articular surfaces at either extremity gives some lengthwise concavity underneath, which, with the lateral convexity, produced by the shape of the extremity of the tarsus, produces a hollowing of the sole that is filled by the flexor tendons, lumbricales, and interosseous muscles. The second is the longest, the fourth is nearly as long, the third, fifth and first successively decrease in length; the last, besides being shortest, is much stouter than the rest, and depressed, being wider than deep. Its divergence from the others, and peculiar articulation, have already been noticed. The proximal extremity of the fifth is enlarged, and projects outside the cuboid; the articular facet only occupies a part of it. The heads of the second, third and fourth are small; that of the third, in particular, being scarcely wider than the shaft, though projecting considerably downward. Other minor differences in the heads of these three metatarsals need not be particularized.

Phalanges.—The four lesser toes have each three phalanges, the first of which is long and slender, surpassing the other two together; the third is simply a small, compressed, somewhat falciform ossicle supporting the claw. The hallux has but two phalanges, of which the last is a small nodule, bearing no claw. This toe terminates in a rounded clubbed extremity, upon the superior surface of which the place of a claw is indicated by a curved groove in the integument. The articulations of the phalanges with the metatarsus, and with each other, offer nothing peculiar.

Sesamoids.—The metatarso-phalangeal articulation of each of the five toes bears two sesamoids upon its plantar aspect. They are rather large, oval, placed side by side, their long axes parallel with the axes of the toes. Those of the great toe are embraced by the tendons of the *flexor brevis*; the others, by the *interossei*. Their presence is not invariable. The sesamoids of the knee joint have been already noticed.

PART II.—THE MUSCLES.

The following account of the muscles is designed to embrace descriptions of all those belonging to the general system. Most of the proper muscles of particular organs, as, *e.g.*, the eye, ear, larynx, heart, etc., and all those of unstriped fibre, are omitted; such being regarded as more properly falling in the province of a special treatise on these parts. Some, however, are noticed in considerable detail; particularly the muscles of the perinæum and genital organs.

An arbitrary division of the body into muscular "regions" being not entirely commendable, nor even practically convenient in many cases, a somewhat different, and perhaps more natural, method of grouping the muscles is followed. It is essentially similar to that lately proposed in my treatise on the Myology of the *Ornithorhynchus* (Proc. Essex Inst., VI, Mar., 1871, p. 127), although lacking some of the details of the latter, which I was led to adopt after the manuscript of the present memoir had passed out of my hands.

Muscles of the Head.

The general muscular envelope of the head and neck may be most conveniently considered here, in connection with the muscles proper to the cranium. Other muscles attached to the skull fall naturally into a different division.

Panniculus carnosus.—The entire head and neck are enveloped in continuous layers of muscular tissue, of somewhat complicated distribution. Although the platysma myoides, occipito-frontalis, and some other muscles of anthropotomy, together with some that are not recognized in man, are included in this general envelope, it may without violence be described as a single muscle, under the above name, with the following structure and disposition:—

A plane of muscular fibres begins over the shoulder and breast, and along the median line of the back of the neck, directly beneath, and intimately adherent by cellular tissue to, the skin. These fibres are the most superficial of all; and will be removed with the skin, if due care be not taken. They proceed forward, those of the side of the neck inclining toward the middle line of the throat, and there meeting those of the opposite side, surround the ear and eye, running a little way upon the former, meet along the median line of the top of the head, and finally end by insertion along the border of the orbicularis oris. This plane is continuous over the whole of the surfaces just pointed out; but its extreme thinness, even in the most muscular subjects, its intimate adherence to the skin, and the varying direction of its fibres in different places, render it difficult to trace in its entirety.

Beneath it lie two other planes of fibres, partially distinct, partially blended with each other and with the foregoing. One of these begins over the upper part of the breast, and runs straight up the median line of the neck, in apposition, or rather in direct coalescence with, its fellow of the opposite side, the two together forming a thin band an inch or more broad. At a point about opposite the angle of the jaws, the muscle widens by an outward sweep of its fibres; thence, nearly to the symphysis, the direction of the fibres is transverse. They form a transverse plane, each joined to its fellow along a median longitudinal raphé lying between the plane first described and the digastrici; mounting upon the side of the head, over the masseter, and becoming lost upon the temporal fascia. This appears to be the true platysma.

The third plane of fibres, although properly a cutaneous muscle, has a very distinct origin, not from the skin. It arises from the ligamentum nuchæ, from the occipital crest to a point opposite the apex of the scapula, just external to the trapezius, which it overlies. It forms in the neck a broad definite plane of fibres, at first proceeding directly transverse, and afterward inclining obliquely forward, as it approaches the median line in front. It loses itself, on the front of the neck, in the general envelope first described. At the back of the head the anterior border of this muscle first sends a slip up the ear, as will be more particularly described presently, and then spreads forward with a nearly longitudinal direction of its fibres, over the temporal fascia, covering the latter from the parietal crest to the zygoma, on a line between the ear and eye. Along the median line of the skull it is loosely connected with its fellow by a fascial expansion, and it seems to constitute an "occipito-frontalis." I cannot trace it beyond the frontal crests, while the plane first described is easily demonstrated to extend quite to the snout.

Auricular muscles.—Three muscles of the ear may be described, besides the superficial panniculus that surrounds the conch, and is subservient to its general movements; only one of them, however, is very distinct, or has bony origin. This is a detrahens aurem; it is a stout, terete, somewhat flattened band, lying beneath, and entirely distinct from, all the foregoing layers. It arises from the lower border of the zygoma, just at the anterior margin of the glenoid fossa; proceeds directly upward and spreads a little, after reaching the conch, upon the back part of the latter. It draws the ear directly downward—what would be forward were the animal erect—and seems to represent our attrahens.

The plane of fibres that arises from the ligamentum nuchæ, sends, from its anterior margin, a large, fan-shaped, flattened fasciculus that mounts and spreads over the back part of the conch. The portion of this fasciculus that lies upon the ear itself is tolerably distinct; but in the rest of its extent the muscle is scarcely separable without violence from the general plane. It draws the conch upward and backward, uniting the offices of attollens and retrahens.

The forward motion of the ear is subserved by the transverse plane of fibres that mount the side of the head from the middle line of the throat; these having an insertion along the border of the conch.

Orbicular muscles.—The *orbicularis oculi* is small and pale, and might readily elude observation by its intimate connection with the panniculus, beneath which it lies, were it not for its definite bony attachment in front. The fibres, after encircling the eyelids, converge to a point and are inserted into the lachrymal bone, just anterior to the foramen. The *orbicularis oris* lies between the mucous membrane of the lips and the panniculus, which, as already stated, reaches to the edge of the true skin all around the mouth. Upon carefully lifting it away the orbicularis is exposed, forming a cylindrical band of fibres around the margins of the lips. These fibres cannot be fairly traced around the snout from one side of the mouth to the other, being lost, both above and below, in the thickened subcutaneous tissue.

Buccinator.—This is, in effect, a backward prolongation of the orbicularis into the cheeks, between the panniculus and the mucous membrane. There is no crossing of the fibres of the orbicularis at the corner of the mouth, nor other interlacing with the cheek muscle. The fibres of the latter form a series of semicircular loops, thrown successively further and further back from the orbicularis, till the angle of the mouth is reached. This muscle is much thickened along its periphery, by which it has definite bony attachment to nearly the whole length of the horizontal ramus and anterior border of the coronary process of the lower jaw, as well as to the greater part of the alveolar process of the upper jaw.

The two foregoing muscles close and appress the lips and cheeks. They are directly antagonized by the panniculus, the line of traction of which, and insertion into the lips, are such that they draw the lips apart, and the angle of the mouth backward, producing the characteristic expression of the opossum's face—the "risus sardonicus." This "showing of the teeth" almost invariably takes place when the animal is irritated; but the muscles upon the face itself have but little effect in its production, compared with the action of the panniculus. I cannot find any muscles upon the lower jaw distinct from the orbicularis and buccinator, to correspond to the several described in anthropotomy; nor do I think that any such exist. There are, however, two very distinct muscles upon the side of the face, subserving the movements of the snout and anterior part of the upper lip, which I shall describe under the names of zygomaticus and levator labii superioris, without feeling at all sure that these names indicate their homology. It is worthy of note, that while these "muscles of expression" of the human subject mainly draw the mouth in different directions, in the present case they move the snout, and only secondarily affect the lips.

Zygomaticus.—This is the principal facial muscle; of large size, definite origin and insertions, and of deeper color than the rest, probably in consequence of its constant action. It lies nearly parallel with the alveolar border of the upper jaw, but still has some downward inclination as it passes forward. It arises fleshy from the root of the zygoma, in the slight depression of the malar bone just below the infraorbital ridge, filling this depression to the general level. It forms a flattened mass that may be divided almost to its origin into distinct fasciculi. These fasciculi are from three to six in number; corresponding to as many slender, terete, but strong, tendons. These tendons are as distinct as, and call to mind, those of a digital flexor. They run forward, embedded in the subcutaneous cellular tissue, as well as in the muscle about to be described, and penetrate to the skin itself. They are directly inserted into the skin of the nostrils at various places about the side of the snout. Neither the number nor the insertion of these tendons is constant; frequently only one or two reach the extremity of the muzzle, the rest being inserted into the skin of the lip just back of the nostrils. It is difficult to describe with exactness the action of this muscle; its several disconnected tendons effect the varied and delicate movements of the extremity of the snout, and of the nostrils themselves, that may be observed when the animal is sniffing about after food.

Levator labii superioris.—The action of the foregoing is aided and extended to the greater part of the upper lip, by means of the present muscle. It arises from the side of the superior maxillary, just below the preceding, a little above the alveolar border, at or near the articulation of the malar, and passes forward and downward, to be inserted into the side of the lip and muzzle. It is entirely fleshy. It draws the lip upward and backward, and the nostril directly backward. Its insertion, not precise at best, varies with individuals; and its bony origin is likewise variable.

Muscles of the Under Jaw.—The enormous bulk of the muscles that close the jaws indicates the force with which this action may be performed. These muscles fill the deep temporal fossa, from the orbit to the occiput, and from the sagittal crest to the zygoma, rendering the cranial depression convex in all directions; and also form a bulging mass both on the inside and outside of the ramus of the jaw. The latter masses are prominently displayed, without dissection, by simply opening the animal's mouth. The external pterygoid, or rotatory muscle, on the other hand, is very small and feeble, correspondently to the character of the maxillary articulation, that admits of but slight lateral movement of the jaws.

Masseter.—This muscle not only forms a bulging mass upon the jaw-bone, from the zygoma to the border of the mandible, but fills the space between the coronoid process and the zygoma, and extends upon the cranium, beneath the temporal fascia, so far as to overlie the greater portion of the temporalis. It has extensive origin from the greater part of the temporal fascia, sometimes as high up as the parietal crest; from the stout fibrous band between the malar and supraorbital protuberance that defines the back part of the orbit, from the lower part of the occipital crest and the squamosal ridge, and from the whole of the inner surface of the zygoma. This temporal or cranial portion of the masseter is inserted into the whole of the outer surface of the broad coronoid plate. The masseteric portion proper, or that lying below the zygoma, arises not only from the lower border of the latter (being directly continuous with the above), but also, and chiefly, by a very stout tendon from the most anterior and lowest part of the malar. While the former portion is flattened and more or less fan-shaped, its fibres converging from the broad origin above described, the latter is a thick bulging mass, the general direction of the fibres of which is backward as well as downward. This prominent bundle overlaps the margin of the jaw, extends to the inner edge, and is inserted into the whole of the broad, triangular, flat space, meeting the lower border of the internal pterygoid. It reaches along the jaw, from the anterior margin of the last named muscle, to the inner hamular process of the mandible. The anterior border of the masseter is blended with the corresponding part of the temporalis.

Temporalis.—On reflecting the masseter, this muscle is seen filling the remainder of the cranial depression, separated from the foregoing (except along its anterior border) by a thick, stout aponeurosis, that forms the true tendon of the temporalis, radiating from the apex of the coronoid much as in the human subject. The periphery of the muscle corresponds to the contour of the temporal fossa; it takes origin from the occipital, parietal and frontal crests, and all the subjacent bones; it is inserted, tendinous, into the top of the coronoid, and fleshy, into the greater part of the inner surface of the same process, which is thus completely embedded in muscle. The temporal is thinner and weaker than the masseter, as well as of less superficial extent; but as already stated, the two are completely blended in some portions, and must always act consentaneously.

Pterygoideus internus.—Like the foregoing, this muscle is of great size and power, well deserving the name of "internal masseter" (Winslow), sometimes applied to it in anthropotomy. Its line of traction is such that it has little or no effect except in direct closure of the jaws. It forms on the inside of the ramus of the jaw a prominently convex bundle, corresponding in extent with, and yielding but little in size to, the masseter. It arises fleshy from the sphenoidal pterapophysis, contiguous part of palatal, and the whole of the pterygoid, which slender little bone projects downward into and is buried in the fleshy mass. Enlarging and bulging as it descends, it is inserted fleshy into the inner surface of the mandibular ramus, from the termination of the temporalis to the margin of the bone, and along the latter from the hamular process as far as the anterior margin of the masseter. It completely fills the depression between the incurved process and the articular head of the bone.

Pterygoideus externus.—The disparity in size between this and the preceding muscle is very striking; the external pterygoid being, as it were, reduced to its simplest expression. It is a very small conical, or pyramidal muscle, and is not divisible, as in the human subject, into two "heads," or parts. It arises fleshy from the alisphenoid, near the median line of the bone, close by the foramen rotundum, and proceeds, narrowing, almost directly outward (a little backward), to be inserted by a very short tendon into the neck of the mandible, directly underneath the most internal point of the transversely elongated articular surface. Its action is necessarily very feeble and much restricted.

Muscles of the Neck.

Under this head I shall describe all the muscles of this region, not confined to the cranium, nor attached to the scapular arch, nor forming merely upward prolongations of those of the back. Without going into unnecessary subdivision of the part into "regions," we may conveniently recognize three groups of muscles: — The anterior cervical, embracing those muscles not attached to vertebræ; the anterior vertebral, including those lying upon the front of the column; and the posterior vertebral, containing those upon the back of the same. Excluded from the first group, by reason of attachment to the scapular arch, are the omo-hyoid and cleido-mastoid; from the second and third, for the same reason, the three levators of the scapula, the trapezius and the rhomboideus; and from the same two groups, as forming the third exception above taken, the cervicalis ascendens, transversalis and spinalis cervicis, etc. The great similarity of the muscles of all these groups to those of the human subject will appear from the following descriptions. The part that the paroccipital plays as a "styloid process" is worthy of note. Among the more notable features, as compared with the state of things found in man, are to be observed, the extension of the platysma myoides into a proper panniculus carnosus, as already described, discretion of sterno-mastoid and cleido-mastoid, peculiar origin of sterno-hyoid and -thyroid, relation of the latter to thyro-hyoid, expansion of digastricus, etc.

Sterno-mastoideus.—Perfectly distinct from the cleido-mastoid, though with the same origin and a parallel and contiguous course. It arises by a short, stout, flat tendon from the mastoid (sometimes from the extremity of the squamosal), and forms a stout fusiform or terete belly, that comes a little obliquely down the neck, immediately beneath the panniculus, crossing the omo-hyoid nearly at right angles, to be inserted fleshy, side by side with its fellow, into the side of the top of the manubrium, and frequently, also, the cartilage interposed between this and the clavicle, in front of, and close beside, the termination of the cleido-mastoid; its termination is in contact with the upper corner of the great pectoral.

Digastricus.—This is the first muscle seen between the jaws upon removal of the integument and panniculus. It is notable for its origin from the paroccipital instead of the mastoid, its want of a central tendon, and the expansion of its anterior belly to form a flooring to the mouth. It is bound down by the common fascia, and so is virtually attached to the hyoid; but it is not distinctly drawn to that bone by a fibrous loop. The posterior belly, stout and terete, curves around the angle of the jaw, just internal to the greater pterygoid muscle, becomes constricted and suffers partial tendinous intersection, and then spreads out into a broad, thin plane, that meets its fellow of the opposite side, and completely fills the interramal space. It is attached to the whole of the inner side of the lower jaw, from the anterior border of the pterygoid muscle to the symphysis. Besides depressing the jaw, it thus floors the mouth.

Mylo-hyoideus.—The proper floor of the mouth lies upon the digastricus — the lingual vessels running between the two. It has no distinct insertion into the hyoid, being only connected with that bone by fasciæ. It is wholly muscular; its fibres are directly transverse; it arises from the inside of the alveolar border of the lower jaw, from the border of the pterygoid to the symphysis, and unites with its fellow along a median raphé.

Genio-hyoideus.—A large flat strip lying in apposition with its fellow along the median line, arising fleshy from the body of the hyoid, narrowing as it passes forward to be inserted by a slight tendon into the symphysis.

Genio-hyo-glossus.—This muscle, with its fellow, forms a thick, vertical, fan-shaped partition between the hyo-glossi. It arises, internal to the preceding, from the inner surface of the anterior border of the hyoid body. Its lower border, running straight to the symphysis, lies upon the foregoing. Its fibres cannot be traced more than half way to the tip of the tongue; its upper border becomes lost in the substance of the tongue (lingualis), and blends with the hyo-glossus.

Hyo-glossus.—A large muscle, forming a great part of the tongue. It arises fleshy from the lower border and most of the side of the hyoid, forming a broad, oblique plane, separated from its fellow by the foregoing muscle. Passing into the tongue its fibres can be traced along the side and under surface, even to the tip. Above and internally, it first blends with the foregoing, and is afterwards lost in the lingualis. Of the latter, it is unnecessary to say more than that it forms the fleshy substance of the tongue not included in the two foregoing muscles, and is without osseous attachments.

"Stylo"-hyoideus—A cylindrical muscle of rather large size, running obliquely forward and inward from the tip of the paroccipital to the apex of the hyoid cornu. This insertion, however, is only partial; some fibres are continuous with the constrictor of the pharynx, and seem to represent the stylo-pharyngeus of anthropotomy. Other muscles of the palate and pharynx do not fall within the scope of the present memoir.

Sterno-hyoideus.—A straight cylinder, somewhat flattened, lying along the median line, upon the sterno-thyroid, in apposition with its fellow. Instead of arising from the top of the sternum, it takes fleshy origin from the inner surface of the latter, from the body of the second sterneber, in conjunction with the (single) sterno-thyroid. It is inserted on either side of the median line, into the lower border of the hyoid. It occasionally gives off, near the middle of its course, a delicate fasciculus that is inserted into the lower outer angle of the thyroid cartilage.

Sterno-thyroideus.—This pair of muscles presents the peculiarity of arising azygos, afterwards bifurcating a little above the top of the sternum. The common muscle of origin takes rise from the body of the second sterneber, on the inner surface of the bone, bounded on either side by the sterno-hyoid, and usually blended with the latter, and terminates in a horse-shoe shaped tendinous constriction, from the sides of which its separate portions commence. These lie directly upon the trachea, covered by the preceding pair of muscles, and pass, as flattened bands of moderate width, to be inserted fleshy into the lower edge of the thyroid, on either side of the median line. A few slender fasciculi are sometimes sent up to join the hyoid bone. The fibrous constriction is sometimes wanting; then the two parts arise by simple forking of the common muscle of origin. The place of bifurcation is also variable; but I have always found it above the sternum, and have not found that the muscle ever arises double.

Thyro-hyoideus.—This is not simply a direct upward prolongation of the preceding, but perfectly distinct and moreover oblique in direction. It is a short, broad plane, entirely fleshy, arising from the lower border of the side of the thyroid, passing inward and upward, and inserted into nearly the whole of the lower border of the hyoid.

Besides those that pass to the shoulder, the muscles of the anterior vertebral group are the three recti of the head, the longus colli and the scaleni.

Rectus capitis anticus major.—This capital prolongation of the longus colli is large and conspicuous, and tolerably distinct from the cervical portion, to which the latter name is usually restricted. It arises by attenuated slips from the transverse processes of all the cervical vertebræ; these slips lying external to those of the longus colli proper. They unite, frequently with slight tendinous constrictions, into a stout, somewhat cylindrical mass, that converges to come into apposition with its fellow over the atlas, and is inserted fleshy into the greater part of the basioccipital.

Rectus capitis anticus minor.—Smallest of the three recti, and completely hidden by the overlying major, from which, however, it is perfectly distinct. It arises fleshy from the whole anterior border of the ring of the atlas, passes directly forward over the condyle and is inserted fleshy, beside its fellow, into the basioccipital at the border of the foramen and root of the condyle.

Rectus lateralis.—A small, but perfectly distinct fasciculus, lying external to the last, separating it from the obliquus superior. It arises from the transverse process of the atlas, and runs obliquely inward and forward to the basioccipital.

Longus colli.—Occupies the front of the vertebral column from the atlas to the fourth dorsal vertebra, arising by slips from the transverse processes of all but the first cervical, and attached to the bodies of the vertebræ as it passes over them. In most of its course it is in relation to its fellow, mesial, and to the rectus major external. Above, the two muscles, or halves of the muscle, converge to meet in a point on the median line of the atlas. The large volume of muscle upon the front of the spinal column and basilar process has evident relation to such a flexion of the head and body as is necessary, for example, in attending to the pouch, or regaining foothold after suspension by the tail.

Scaleni.—I have never been able to demonstrate three; the second one—the medius—cannot be found at all, and the first (anticus) is small and blended with the third (posticus); the latter is large and conspicuous. The S. anticus, when tolerably distinct, arises from the most lateral points of the transverse processes of two or three lower cervicals, and is inserted into the first rib, near the middle of the latter, just in front of a slip from the serratus magnus. The S. posticus is perfectly distinct as to the thoracic portion. It arises from the transverse processes of all the cervicals as high up as the origin of the levator scapulæ. separating this from the rectus capitis major. Widening and flattening as it descends, it passes outward as well as downward, behind the subclavius, to be inserted by three, broad, flat, fleshy digitations into the posterior borders of the second, third and fourth ribs, near their middle, just over the corresponding digitations of the serratus, and behind the outer border of the thoracic part of the rectus abdominis. It is a direct levator costarum and flexor cervicis. Its cervical origins are sometimes blended with those of the levator anguli scapulæ for a little distance.

The muscles upon the back of the neck are the same as those found on this part of the human body. The only notable differences lie in their relative size and configuration; and even in these respects the discrepancy is not great, except in the instances of the rectus capitis posticus major, and obliquus capitis inferior, both of which are of great proportional size. The trapezius and rhomboideus are described under head of the anterior extremity; the cervicalis ascendens, transversalis cervicis, and spinalis and semispinalis cervicis in connection with the muscles of the back, of which they are all merely the upward prolongations. The remaining muscles are :—

Splenius.—Exposed upon removal of the trapezius and rhomboideus. It forms, with its fellow of the opposite side, an isosceles triangle whose base is the crista occipitis, and perpendicular the ligamentum nuchæ. There is no lower portion corresponding to the "splenius colli," so called; the muscle terminates below in a sharp, distinct point upon a spinous process of a vertebra. It has unbroken origin from the ligamentum nuchæ, and by this from the spines of three or four upper dorsal and six lower cervical vertebræ; forms a moderately thick plane, with a thickened external border; widens as it ascends, and is inserted into the whole of the occipital crest. As the spinal origin of the muscle ends with the axis, and the median border is not always directed straight forward, nor inserted exactly on the middle line of the skull, it results that a small, triangular space between the muscle and its fellow is often, or usually left. In this space the rectus posticus major and part of the obliquus inferior appear. Otherwise, the splenius overlies and hides the greater part of the nuchal muscles.

Biventer cervicis.—On reflecting the splenius the following muscles more particularly come to view :—biventer cervicis, complexus and trachelo-mastoideus, counting from the spine outward, along the whole length of the neck, together with the two largest of the head-muscles, and the several strips of muscle coming up from the back. The biventer lies nearest the spinal column, and is ordinarily perfectly distinct from the complexus; but liable to be partly or wholly blended with the latter, in which case it forms its medial border. Its name does not express its physical character; it has no central tendinous part, but only a slight constriction, produced by irregular, fibrous laminæ, that form partial intersections. It is the longest muscle of the back of the neck; a sub-cylindrical strip, with no definite attachments along its course. It arises by slips from the transverse processes of the fifth, sixth and seventh dorsal vertebræ (but number of slips variable), lies in the same plane as the complexus, and is inserted fleshy into all that (median) part of the occipital crest not occupied by the following muscle.

Complexus.—A very large and rather thick plane of fibres separating the foregoing from the succeeding muscle; there is nothing specially "complex" in its structure. It arises by eight to ten long, slender, very distinct, fleshy fasciculi from the anterior margins of the bases of the articular processes of the six lower cervical, and two, three or four upper dorsal vertebræ. The lower fasciculi are much the longest, and rapidly diminish in length from below upward; uniting, without tendinous intersections, to form a single broad plane, curving over toward the spine, its anterior border in relation to the biventer; inserted by a short, broad, dense, glistening aponeurosis into all, or nearly all, the occipital crest. The muscle has also an attachment to the margin of the transverse process of the atlas, as it passes over the latter.

Trachelo-mastoideus.—Overlying the latter to the outer side; a muscle of considerable size. It arises by about ten long, slender, distinct, fleshy fasciculi from the articular processes of the six lower cervical and three or four upper dorsal vertebræ, close by the origins of the complexus. These fasciculi soon blend, frequently with a slight tendinous intersection, into a common plane, rather thin, and narrowing rapidly as it ascends, till it comes almost to a point above. Its insertion, by a short, stout, flattened tendon, is ordinarily into the extremity of the occipital crest, and therefore into the squamosal; but sometimes into the mastoid just underneath this point. In most of its course it is in relation externally with the levator anguli scapulæ; internally it lies upon the complexus.

Rectus capitis posticus major.—Of large size, much surpassing the other rectus, though in turn surpassed by the obliquus inferior. It is a stout, thick, fleshy band, arising from the side of the extended curved upper margin of the spinous process of the axis, and corresponding part of the third cervical spine, extending outward as it passes forward (but not so obliquely as the obliquus inferior) to be inserted fleshy into the greater part of the depressed occipital space—all that portion of the bone between the rectus minor and complexus, from near the median line of the skull to the insertion of the obliquus superior.

Rectus capitis posticus minor.—Very much smaller; perfectly distinct; a little flattened, fleshy band, in apposition with its fellow, running straight from atlas to occiput; arising from the whole of the posterior border of the atlas-ring, from median line to base of transverse process; inserted into the occipital depression, just below the foregoing muscle.

Obliquus superior.—A small muscle, perfectly straight in its course; arising from the tip, anterior border, and most of under surface of the transverse process of the atlas, in relation in front with the rectus lateralis; inserted fleshy into the side of the base of the occiput, between the extremity of the crest and the root of the paroccipital process.

Obliquus inferior.—As was to have been anticipated, viewing the great size of the axial spine, and transverse production of the atlas, this muscle is of great extent and power. It is the only one of the four at the base of the skull that is decidedly oblique to the long axis of the neck. It arises fleshy from the whole of the expanded side of the axial spine, and is further prolonged in a point upon the side, near the tip, of the spines of the third, fourth and fifth cervicals; fills the deep longitudinal fossa along these vertebræ, passes very obliquely outward and forward, lying upon the surface of the atlas, between this and the rectus major, and is inserted into the margin, lower edge of base, and upper surface of the transverse process of the atlas. Its divarication from its fellow leaves a broad, triangular space in which the recti majores are seen. This muscle, with the great rectus, might together be almost mistaken, at first glance, for the complexus itself.

Muscles of the Thorax.

Most of the muscles lying upon the chest proceed to, or come from other parts, and are considered in other connections. This leaves only the following to be described under this head:—serratus superior and inferior; "sterno-costalis;" triangularis sterni; intercostales externi and interni; infracostales; levatores costarum; and the diaphragm.

Serratus posticus superior.—A muscle of large size, arising by a continuous aponeurotic lamina from the transverse process of the sixth (seventh?) cervical vertebra, and first two ribs; and by fleshy digitations from the third—ninth ribs; inserted into the spinous processes of corresponding vertebræ. The direction of the fibres from the spine is obliquely outward and downward. In its upper portion, fleshy fibres almost reach the spine; below, the aponeurosis of attachment grows broader. The last fleshy fasciculus is very short, and interdigitates with one from the obliquus abdominis, about two inches from the spine.

Serratus posticus inferior.—The direct downward continuation of the plane of the foregoing, but effectually a distinct muscle, by a difference in the direction of its fibres. On account of the wider intercostal spaces below, the fleshy digitations are much broader than those of the S. superior. They are four in number, arising from the tenth—thirteenth rib, interdigitating with the obliquus abdominis. Although they decrease in length from above downward, the lower one reaches nearest to the spine, in consequence of overbalancing decrease in the breadth of the aponeurotic attachment. The fibres of this muscle are directly transverse; and, while the S. superior lifts the ribs, this draws them directly away from the median line, and so continues expansion of the chest below.

"*Sterno-costalis*."—There is a small muscle upon the outside of the thorax, regarding the name and homology of which I am in doubt. It arises by a thin aponeurosis of varying width, from the second, and sometimes part of the third, sterneber, this aponeurosis lying between the pectoralis major and rectus abdominis, and closely investing the latter. It proceeds obliquely forward and outward; at the external border of the rectus it becomes fleshy, and proceeds to be inserted fleshy into the first rib, opposite the insertion of the scalenus anticus. In general characters it recalls the pectoralis minor, and may possibly be regarded as that muscle, arrested on its way to the coracoid, since the three pectorales elsewhere described are really only dismemberments of one — the pectoralis major.

Triangularis sterni.—This muscle is of considerable superficial extent, but very thin, and usually divided into halves along the median line, by an interval corresponding to the width of the sternebers. Each half arises as a continuous plane along the outer border of the four lower sternebers (not from the xiphoid), and proceeds obliquely outward and forward, lying upon the whole of the costal cartilages of the second—sixth ribs.

Intercostales.—The *externi* terminate on the "true" ribs at some distance from the sternum (in general, along the outer border of the rectus abdominis); but on the floating ribs they reach to the margin of this bone. The upper ones are most oblique and shortest; the lower ones are nearly vertical. The *interni* cover the whole of the inside of the thorax from spine to sternum. The direction of their fibres decussates with that of the preceding muscles in the usual way.

Infracostales.—At the back of the thorax, near the spine, the internal intercostales run over two or three contiguous ribs instead of being confined to a single costal interspace. The plane of these elongated overlapping intercostals is directly continuous; the inner surface is blended with the successive true intercostals. The width of the series is least above; toward the bottom of the thorax it increases; and similarly the individual infracostals elongate, widen, and become more distinct.

Levatores costarum.—A well marked series of little oblique muscles, running from the apex of a transverse process to the succeeding rib. They arise fleshy, and are inserted partly tendinous into the rib between the tuberosity and the angle. The lower ones are longest, as well as largest and most distinct; some of them have two heads, taking origin (by the outer head) from the rib above, as well as from the transverse process. Their collective force in elevating the ribs would be considerable.

Diaphragm.—With little modification the description of the human diaphragm would apply to that of the opossum. The central tendon commonly resembles the trefoil in shape, but varies with individuals from the trefoil through cordiform to broad reniform. It is equidistant from the circumference of the thorax, but the middle leaflet approaches the xiphoid, and each lateral leaflet the two last ribs. The muscular fibres radiate in all directions from the central tendon; the plane going to the xiphoid in the thinnest, and sometimes almost divided along the median line by a membranous interval. The lateral fibres terminate about an inch from the margin of the thorax, by separated flattened fasciculi, one for each floating rib, interdigitating with those of the transversalis abdominis. The digitations sometimes only fairly blend just before reaching the central tendon; but there is great individual difference in this respect, as well as regarding the general thickness and fleshiness of the muscle. The two crura are of unequal lengths; the right, besides being longest, is also stoutest. It ends on the body of the third lumbar; the left usually between the second and third; both are directly continuous below with the anterior vertebral ligament. The anterior margins of the crura are tendinous; behind, muscular fibres descend to the insertion of each crus, and are attached to the vertebra just above. The anterior tendinous border of each crus curves over about an inch above its final insertion, to become continuous with its fellow of the opposite side, overarching and enclosing the aortic opening, the margin of which is thus, as usual, entirely fibrous. The muscular fibres of the two crura decussate just above the aortic opening, at a slight angle, and then divaricate to surround the œsophageal aperture. The latter is a fissure, bounded on both sides and below by muscle; above, it just reaches the border of the central tendon. Its left margin, representing fibres that come from the right crus, is thicker than the other, and forms a well marked ridge or fold. The foramen for the vena cava is situated above and to the right of the œsophageal, in the central tendon, at the junction of the central and dextral leaflets. It is circular, and the smallest of the three principal openings; the fibres that form its periphery are thickened and strengthened; the most noticeable of these increased fibres is a set that proceeds from the margin of the opening obliquely to the œsophageal fissure. The "ligamentum arcuatum" passes from the posterior margin of each crus to the transverse process of the first lumbar, and base of the last rib, overarching the spine transversely. It is more or less directly continuous with the fascia of the transversalis abdominis. The psoas parvus and lumbar muscles pass up a little way behind it. I do not notice any "internal arcuate ligament" well distinguished from the rest of this border of the muscle.

Muscles of the Back.

Of the numerous muscles of the back, those constituting the first three "layers," as usually described in anthropotomy, and part of those constituting the fourth and fifth layers, are described in other connections, *to wit:* the trapezius, latissimus, rhomboideus and levator anguli scapulæ, with the muscles of the anterior extremity; the two serrati postici with the muscles of the thorax; the splenius, biventer, complexus, trachelo-mastoideus, recti capitis superior and inferior, with the muscles of the posterior vertebral region of the neck. The general disposition of the muscles that remain to be noticed is much the same as in man; the chief differences are found in the lumbar and sacral region, and relate to the development of large caudal muscles. The following description may suffice to exhibit the characters of the remaining muscles of the fourth and fifth layers, without going into tedious and unnecessary detail.

In the loins, that is, from the apex of the ilium to the last rib, there is on either side a large sub-cylindrical mass of muscle, divisible into five parallel, longitudinal bundles.

The innermost, or most lateral of these, seems to represent a series of "intertransversales," lying between and upon the large "transverse processes," separating the psoas from the quadratus lumborum. It takes origin from the ilium, below and inside the apex, and proceeds upward to the eleventh — twelfth rib, thus entering the thorax, past the diaphragm, and there lying upon the anterior surfaces of the bodies of the vertebræ.

The next three bundles occupy the broad, shallow fossa between the transverse and articular processes. The largest and most lateral of these is the quadratus lumborum, beginning at the apex of the ilium, and proceeding to the last rib. It is wholly muscular, and incompletely divisible into several layers of fasciculi; and blends above with the sacro-lumbalis. The latter, and the longissimus dorsi—both to be presently noticed in more detail—together form the third bundle, and constitute the "erector spinæ." The fourth bundle is the very distinct, terete belly of origin of a caudal extensor, described below.

The fifth bundle occupies the narrow deep fossa between the articular and spinous processes, representing a "multifidus spinæ." Below, it runs uninterruptedly into the tail. It consists of a series of little oblique fascicles, filling the groove, arising fleshy from articular processes, and inserted tendinous into spinous processes, two or three vertebræ above. At the last dorsal its bed becomes very narrow and the muscle is proportionally diminished in size. It again enlarges, however, and continues upward, with much the same characters, but intimately blended with the spinales dorsi and colli.

The erector spinæ in the lumbar region consists mainly of a series of flattened tendons that take origin from the apices of the spinous processes, and blend into a strong fibrous layer that invests the subjacent muscle, and is continued as a strong fascia down over the sacrum. Laterally, and toward the thorax, however, the sacro-lumbalis part becomes a stout fleshy mass that blends with the quadratus, and is then continued upon and inserted into the last two or three ribs, at a little distance from the spine.

The upward prolongation of the sacro-lumbalis—the "musculus accessorius"—is perfectly distinct from the longissimus. It is a flat, narrow, sub-prismatic strip lying along the outer border of the latter, just behind the origins of the serrati, an inch or more from the spine. It consists of a series of slips arising fleshy from the ribs, and inserted tendinous into the second or third rib above. The several tendons are tolerably distinct, but the muscular parts are completely blended.

This muscle, properly speaking, ends at the first rib. To its outer side, and partially blended with it, a slip arises from the third—first rib, and is inserted into the transverse process of the seventh cervical. This is the "cervicalis ascendens."

The erector spinæ, after disengaging the sacro-lumbalis, continues upward upon the spine, overlying the multifidus, and more immediately the spinalis, as the longissimus dorsi. The latter is distinct from the sacro-lumbalis, but inextricably blended with the spinalis. The longissimus and spinalis together fill the groove between the ribs and the apices of the spinous processes; the former nearest the median line, the latter more external. Together they consist of a series of long, stout, flattened tendons, arising from the apices of the spinous processes, and continually giving off numerous fleshy slips that are inserted into the articular and transverse processes of the vertebræ, and angles of the ribs. The two muscles, hitherto confused, separate opposite the fourth or fifth dorsal,—the origin of the biventer cervicis intervening. The longissimus passes outside the biventer, complexus and trachelo-mastoideus, separating the latter from the cervicalis ascendens, and continues up the neck as the "transversalis cervicis." This forms in the neck, and along the upper part of the thorax, a tolerably distinct flattened muscle, divided into slips that continue below as longissimus, and are inserted above into the transverse processes of the third—seventh cervical vertebræ, by as many separate tendons. It separates the lower part of the trachelo-mastoid from the upper part of the levator anguli scapulæ. The spinalis, likewise running up the neck, passes inside the biventer and complexus, and terminates in a series of stout, fleshy slips lying upon the sides of the spinous processes of the vertebræ, and inserted near their apices, as high up as the third cervical—where the greater rectus and obliquus capitis begin.

Muscles of the Tail.

The muscles of this part, as usual in prehensile-tailed animals, are large and numerous, and especially notable for the extent of their attachments to the pelvis, and sacral and lumbar portions of the spine. They form an elongated cone, diminishing rapidly just behind the pelvis, and thence tapering regularly and very gradually to the tip of the tail. For a little distance beyond the root of the tail, all the muscles are perfectly distinct, and most of them are directly continuous; in the rest of their course, those that extend the entire length of the tail become more or less blended, diminish in size both by the actual decrease of the volume of muscle and by the giving out of fasciculi to be inserted by tendons at various points, and lose continuity in a measure by being firmly attached to the salient points at the extremity of each vertebra, so that, in effect, they are a succession of short muscles. Certain tendons, however, run the entire length of the tail without intermediate insertion; these are described below.

The structure and disposition of the flexing set of muscles is the same as that of the extending; but in bulk, and consequently in power, it greatly preponderates over the latter. This confers the grasping power of the tail; while the extent of pelvic and vertebral attachments of both sets of muscles is sufficient to support the weight of the hanging body without inconvenience. Although the volume of muscle toward the tip of the tail is inconsiderable, the animal can suspend itself from a suitable object, as a twig, by only wrapping around it an inch or two of its tail. The large muscles of the base of the tail are in this case really brought into play by the action of their long tendons. Action of the flexor muscles is favored and increased by the series of V-shaped bones that serve as so many *points d'appui;* and after the spinous, transverse and articular processes cease, the quadrangular extremities of the vertebræ replace these processes as points of muscular attachment and action.

Besides the caudal muscles proper, others take origin from the coccygeal vertebræ. These are:—the posterior part of the glutæus maximus, the "femoro-coccygeus" (when this exists as distinct from the latter), the cruro-coccygeus, the pyriformis (if the disputed vertebra be really caudal), and the levator recti. These are all considered in other connections.

On stripping off the thick, squamous, reticulated skin, the tail is seen to be encased in an uninterrupted sheath of very dense fascia, comparable for thickness and strength with the ordinary fasciæ of the body, much as the *fascia lata* of the human subject compares with similar structures in other parts of the body. This fibrous sheath gives off septa from its under surface that penetrate between, and separate, the different bundles of muscle, and is attached to the salient points of all the vertebræ. The series of septa that it forms between the V-shaped bones, separating the two principal flexing bundles, is the strongest. The long tendons above referred to lie embedded in this fibrous sheath, and are thus plaited, as it were, into stout, flattened bands. These bands are four in number, two above, and two below, on each side of the median line; the tendons of each are from twelve to twenty in number, and may be distinctly seen without dissecting, lying close beside each other, most of them running the whole length of the tail, but some ending by attachment to nearer vertebræ. In general effect, these bands of tendons call to mind the conjoined tendon of a digital flexor, before the filaments become separate from the common bundle. Each tendon arises from a muscular fasciculus in the sacral or pelvic region, as will be presently noticed. Besides encasing the tail, the fibrous sheath gives origin, by its under surface, to muscular fasciculi, particularly along the course of the tendon-bands, which cannot be raised from the subjacent muscle without laceration of the latter.

On either side of the median line, on the superior aspect of the tail, a rather small multifid muscle occupies the groove between the spinous and articular processes. This is the backward continuation, unbroken, of the series of slips that fills the same groove in the lumbar region, and it has precisely the same characters. Fasciculi constantly arise from successive vertebræ, and blend externally and superiorly into a continuous band. These slips are, or rather this muscle is, distinct, as far as the sixth—eighth caudal; there it virtually ends, partly by insertion by separate tendons into the proximal extremities of the vertebræ, but chiefly by attachment to the under surface of the tendon band. The few fleshy fibres that may be traced nearly to the tip of the tail, on the under surface of this band, between its successive attachments to the vertebræ, may properly be regarded as the continuation of this muscle.

The chief extensor muscle of the tail lies next to the preceding, on the outer side of it, as far as its muscular part extends; above it, along its tendinous portion. This is the muscle that forms the bundle of long tendons. It arises high up in the lumbar region, where it forms a distinct belly lying in the groove between the articular and transverse processes, covered by the aponeurotic origin of the erector spinæ, and behind, or to the median side of, the quadratus lumborum. In the sacral and upper caudal region it completely fills the groove—at first between the articular processes and the ilium, subsequently between the same processes and the transverse. It consists of a large number of fasciculi, taking fleshy origin from successive vertebræ at the very bottom of the fossa, and each ending in a long, slender tendon. The course and arrangement of these tendons has already been noticed. The fasciculi that form the tendons may all be easily dissected apart to their very bases, and form in effect so many small muscles. Most of them become tendinous at nearly the same point—opposite, or a little beyond, the tuberosity of the ischia. Two or three of the most posterior of them, however, continue fleshy for a greater distance.

To the outer side of the foregoing lies another smaller muscle, properly belonging to the extensor series, but really subservient to the lateral movements of the tail. It represents the continuation, behind the ilium, of the most lateral or ventral series of the lumbar muscles. It arises fleshy from the transverse processes of the sacrum, and corresponding aspect of the ilium, and forms a small, continuous bundle, situated upon the very apices of the successive transverse processes as long as the latter continue to be developed.

Well developed interspinals and intertransversals connect these processes as long as the latter continue of normal size and shape. The first named muscles disappear first.

The foregoing muscles all proceed over the back of the pelvis to the tail, above the median lateral line of the latter. The remaining muscles constitute the flexor series; these are best displayed by cutting open the symphysis pubis, and wrenching the sides of the pelvis apart. Three arise from the innominate bone; another (not here described owing to an accident that destroyed my notes) arises from the face of the sacrum.

Ischio-coccygeus.—The most lateral of the flexor series. It arises fleshy from the edge of the ascending ramus of the ischium, just below its junction with the ilium, and spreads out to form a broad, fan-shaped muscle, that is inserted by separate fasciculi with the transverse processes of the five or six upper caudals—beginning with the one next to that from which the pyriformis arises. Its anterior border is in relation with the posterior border of the latter muscle. Its action chiefly subserves the lateral movements of the tail, besides serving as another attachment of this member of the body.

Pubo-coccygeus.—This is the most anterior fasciculus of the general plane of muscle that arises from the inner surface of the *os innominatum.* It takes distinct fleshy origin, from the horizontal ramus of the pubes, opposite the articulation of the marsupial bone; and proceeds as a flat slip inward and backward, along the border of the ilio-coccygeus. It has partial insertion, by aponeurosis, into the apex of the second V-shaped bone, but is chiefly directly continuous with the following muscle:—

Ilio-coccygeus.—Arises fleshy from the iliac bone not far from its middle, and represents the posterior lateral part of the intra-pelvic muscles that pass to the tail. Narrowing somewhat from its original dimensions, it passes out of the pelvis alongside the preceding, with which it is partially blended, and continues on the under surface of the tail, close to the median line. These muscles, and the sacral ones, are of considerable size, and form the bands of flexor tendons already noticed.

Muscles of the Abdomen.

The abdominal parietes are formed of five muscles, as in man, besides the *quadratus lumborum*, which was noticed in another connection. The pyramidalis, rudimentary or absent in the human species, is here highly developed, as in the Monotremes proper; the external oblique, and rectus both have extensive thoracic prolongation.

Obliquus externus.—This muscle is of great superficial extent. It arises by ten or eleven thick fleshy fasciculi, from as many lower ribs, interdigitating with each of the three serrati, but not with the latissimus dorsi. The external border of the latter overlies the whole origin of the obliquus. The fleshy digitations begin at the middle of the second—third rib, and upon successive ribs approach nearer the spine; the last one arises at the junction of the costal cartilage with its rib. From this point, the posterior margin of the muscle descends straight to the tip of the ilium, and is bound down by a layer of common intermuscular cellular tissue, hardly to be called an aponeurosis of the obliquus internus (outer layer of lumbar fascia). From the tip of the ilium to the base of the marsupial bone the lower border forms a well defined, stout "Poupart's ligament," continuous below with the general fascia of the thigh; beneath it, near its middle, the femoral vessels emerge with the anterior crural nerves to the outside. The insertion of Poupart's ligament is rigidly defined; it is into the inner aspect of the extreme point of the outer prong of the base of the marsupial bone, just opposite the origin of the pectineus. This narrow, distinct, glistening tendon forms the outer "pillar of the ring." The "ring" is of large size, and pyriform or elliptic contour, its broadest part uppermost. About an inch from the insertion of the tendon, the fibres curve away from its border, overarching the ring, and descending again on the inner side nearly or quite to the base of the marsupial bone, forming the "mesial pillar." The contour of the ring is well marked; an "intercolumnar fascia" closes the opening; the spermatic cord enters at its lower corner. After forming the mesial pillar, the aponeurosis is firmly attached to the whole length of the marsupial bone, as it passes over the outer surface of the latter to proceed to its final insertion into the linea alba and symphysis pubis. The muscle is thick and fleshy as far as the outer border of the rectus, where it becomes aponeurotic, and closely invests the rectus, as far down as the beginning of the pyramidalis, after which it lies directly upon the latter. In the inguinal region it becomes aponeurotic along an imaginary line drawn from the top of the ilium to the top of the marsupial bone. All but the most superior and anterior of its fibres pass almost directly downward.

Obliquus internus.—This muscle is much smaller than the preceding, as well as thinner; its superficies equals that of the abdomen alone. It arises fleshy from the greater part of Poupart's ligament, and from the apex of the ilium, and, by an aponeurosis common to it and the transversalis, from the lumbar fascia. The lower border is fleshy, and stretches nearly horizontally inward from Poupart's ligament to the upper part of the marsupial bone, a stout bundle of fibres being inserted into the tip of that bone. The rest of the muscle passes more and more directly upward, till its posterior part is vertical. Its anterior margin ends along a "linea semilunaris" by blending its aponeurosis with that of the transversalis. This termination of the fleshy fibres is along a straight, oblique line from the tip of the marsupial bone to the most dependent point of the tenth rib. From this line inward no separate aponeuroses for internal oblique and transversalis can be demonstrated; and the same is the case with the lumbar aponeurosis back of a line from the tip of the ilium to the last rib, though it is presumable that two fibrous layers enter into the composition of these aponeuroses. The costal insertion of the muscle is by three or four fleshy digitations into as many of the lower ribs.

Transversalis.—Except for a small space, as noted below, this muscle is fleshy throughout. It arises fasciculate from the inner surfaces and costal interspaces of all the floating ribs, interdigitating with the diaphragm; the lumbar aponeurosis of origin is formed by coalescence of two layers enclosing the quadratus; upon which, and upon blending with the border of the internal oblique, the muscle becomes fleshy. It is attached fleshy to the top of the ilium; its lower fleshy border is not directly continuous with the cremaster, so that the latter does not appear, as in some animals, as a direct scrotal prolongation of the transversalis; but is separated from the latter, more or less perfectly, by an areolar interval, and may usually be traced to the ilium itself. The transversalis, thickest above, is everywhere transverse in the direction of its fibres, the uppermost of which overlie the xiphoid cartilage; and along the upper two-thirds or three-fourths of its length fleshy fibres reach the linea alba. There is no splitting of the aponeurosis to get outside the rectus below; near the point where the muscle passes outside the rectus in the human subject, fleshy fibres cease, and thence downward the muscle is inserted into the linea alba by an aponeurosis as broad as the rectus is wide, completing, with its fellow of the opposite side, an oval space. This fascial layer represents the conjoined aponeuroses of transversalis and internal oblique; it lies wholly inside the rectus.

Rectus. ("*Rectus internus.*")—The straight muscle is noteworthy for its extensive thoracic prolongation, absence of "lineæ transversæ," and situation wholly outside the two preceding. It is a continuous broad flat strip, running the whole length of the trunk from apex of thorax to symphysis pubis. It arises fleshy, about half an inch broad, from the sternal portion of the first rib, and lies along either side of the median line of the body, at first directly upon the ribs and sternum, where it is separated from its fellow by the origin of the pectoralis; and afterward upon the transversalis and internal oblique aponeürosis. Its thoracic portion is immediately covered, at first by the little "sterno-costalis" (see supra) and then by the pectoralis; but the greater part of this portion is directly overlaid by the external oblique. In the upper half of its abdominal extent, it is also covered by the same, and intimately adherent thereto; as well as, mediately, by the third division of the pectoralis. From the termination of the latter to the symphysis, the pyramidalis intervenes between the rectus and the external oblique. The rectus is inserted fleshy into the lower part of the marsupial bone, and the symphysis pubis. Its great size, continuity of contractile tissue, and especially its thoracic prolongation, render it an unusually powerful flexor of the body, in obvious relation to the several indications that have already been pointed out, as requiring fulfilment in the opossum's economy.

Pyramidalis. ("*Rectus externus.*")—Of much the same proportions as in the true Monotremes: similarly developed in both sexes. It is a large triangular plane, wholly muscular, lying between the body of the rectus and the aponeurosis of the external oblique. It arises from the symphysis and whole length of the marsupial bone; the fibres proceeding diagonally upward and inward to be inserted into the linea alba, as high as the origin of the lowest pectoral. This muscle, acting with its fellow, approximates the marsupial bones, and appresses them to the abdomen, which action is furthered by the rectus, and opposed by the three lateral muscles of the abdomen, and also by the pectineus.[1]

Cremaster (of the male).—The spermatic cord, coming from the abdominal scrotum, passes over the base of the marsupial bone, enters the ring at the lower part, and at once divides in three parts. The vas deferens, abruptly changing its course, winds around the bone just named and passes inward to the base of the bladder, soon joined by the ureter. The artery and vein take a middle course together, running, generally upon a bed of fat, only about half way up to the renal vessels, to empty into the aorta and cava (not renal) vein, on either side. The cremaster, only slightly changing its course, runs outward, parallel with the lower border of the transversalis, and is apparently given off from the latter; but it is, however, usually traceable in its integrity to the top of the ilium, where it really takes origin. I doubt that the change in the direction of the cremaster, by passing over the foot of the marsupial bone, is sufficient to decidedly augment the traction of the

[1] The human pyramidalis, small, variable and rudimentary or wanting, has been supposed to be present for the purpose of facilitating "the expulsion of the last few drops of urine." (See respectable text books of human anatomy.) Writers who hazard so absurd a conjecture would do well to look up their comparative anatomy, and learn that morphology may require presence of parts for its own sake.

muscle upon the testicle. There is scarcely more deviation from a right line than would be produced by the passage of the muscle over the brim of the pelvis alone.

Cremaster (of the female: Ilio-marsupialis).—The same muscle in the female, instead of forming a "round ligament of the uterus," goes to the pouch, and has essentially the same relations to the mammary glands that the male muscle bears to the testicle. "The compressor muscle [of the marsupial mammæ in general] arises from the ilium between or near to the lower attachment of the internal oblique and transversalis abdominis; it passes out of the abdominal ring, bends round the marsupial bone, expands as it turns upward and inward behind the pouch to surround partly by carneous, partly by sclerous fibres, the mammary glands, dividing into as many insertions as there are glands of its own side. This muscle ('ilio-marsupialis' of Cuvier) is the homotype of the cremaster of the male; and the chief function of the ossification of the internal pillar of the abdominal ring (marsupial bone) is to add the power of the pulley to the compressor of the mammary gland, and effect the requisite change in the course of the contractile fibres." (OWEN, Comp. Anat. III, p. 769.) The change in direction is much greater in this case than in the instance of the male cremaster, and undoubtedly may have the effect ascribed. The strong powers of suction that the infant opposum has been shown to have, however, might be supposed to render such office unnecessary, or at least of only secondary importance to the function of protruding the nipples from the folds of the integument in which they are invaginated before coming into use; but both these actions may be fairly attributable in some measure to this muscle.

Muscles of the pouch.—The formation of the pouch is essentially the same as that of the scrotum; the two are evidently homologous parts. Each consists of a duplication or bagging of loose integument of the abdomen; in the one case, a loosely pendulous closed sac is formed by eversion and protrusion of a tegumentary fold from within; in the other, a more closely appressed open pouch results from inversion and invagination of a duplication of skin from without; in both, the receptacle so formed lodges the most important sexual glands. Contraction of the scrotum and its contents is effected by the cremaster and the dartos; corresponding actions upon the pouch and mammary glands by the ilio-marsupialis, as has just been seen; but further contractibility than dartoid tissue could afford being evidently required, special muscles make their appearance. The question of the homology of these muscles with the contractile scrotal tissue is one on which I am not prepared to speak; nor can I give so full an account of the muscles themselves as would be desirable. My opportunities were very unfavorable, all my female subjects having been virgin, with the pouch consequently not fully developed. In my dissections I only succeeded in demonstrating transverse and lengthwise planes of muscular fibre between the layers of integument, without being able to define them with precision. According to Owen's brief description, (the only one accessible to me at the time of writing), the marsupium "is composed of a duplicature of integument, of which the external fold is supported by longitudinal fasciculi of the panniculus carnosus, converging below to be implanted in the symphysis pubis. The mouth of the sac is closed by a strong cutaneous sphincter muscle." (Op. cit., p. 770.) This "sphincter" is undoubtedly the transverse fibres I saw, the longitudinal ones just mentioned being those of the general cutaneous muscle.

Muscles of the Perinæum.

Although these muscles, properly speaking, belong rather to special organs than to the general frame-work of the body, and consequently, like the pharyngeal, laryngeal, and some others, scarcely fall within the scope of the present memoir, I give them brief notice, on account of their intrinsic interest. The muscles of the organs of generation, as might be expected, offer some unusual conditions, as compared with those of ordinary mammals, though they are not peculiar to the animal in its own order.

Sphincter ani.—The external sphincter, which surrounds and includes the uro-genital as well as the anal orifice proper, is rather small and thin, and very intimately adherent to the integument around the common opening. It is circular in general outline, but after embracing the anus extends forward, with a fascial attachment towards the symphysis, over the dorsum of the penis, when the latter lies occluded by retraction. It is presumed to aid or continue the erection of the organ, when the latter is protruded, by compressing the dorsal veins.

Sphincter cloacæ.—Within or above the preceding lies the proper sphincter of the rectum, which appears to represent the "internal sphincter" of anthropotomy, and to be formed mainly or wholly by an aggregation of the circular fibres of the rectum; it has no direct action upon the genital apparatus.

Levator ani.—The muscular floor of the pelvis is well developed. It forms a rather thin, subcircular plane, corresponding, in a general way, to the contour of the pelvic outlet; and embraces the genitalia as well as the rectum. Posteriorly, where the muscle is thickest, the margin is free, or at least without direct fascial attachment to the caudal vertebræ; and the fibres run uninterruptedly from one side to the other. These circular fibres curve forward on either side, and converge over the penis; the anterior and lateral margins of the muscle have extensive, though diffuse, fascial attachment to the ischia and pubes—to the latter more particularly. Large masses of fat usually rest upon the levator, forming protuberances on either side of the rectum.

Levator recti. (*Recto-coccygeus*).—This little muscle appears to compensate for want of decided attachment of the levator ani to the coccygeal vertebræ behind: it may really belong to that muscle, but my dissections showed it as distinct. It is a delicate fasciculus, of considerable length, that arises from the chevron bone of the second or third coccygeal vertebra, or both, and proceeds forward and downward above the plane of the levator ani, to the rectum itself, upon which it spreads. It makes direct traction upon the gut, and must exert considerable force when the tail is fixed, notwithstanding its delicate proportions.

Levator penis.—This peculiar muscle, the most exceptional of the set acting upon the organ, as it appears to be characteristic of those marsupials that have a forked glans, and is not found throughout the order, occurs in a highly developed and curious condition. It is the most superficial and lateral of the penal muscles, and is immediately exposed upon removal of the levator ani, above the plane of which it lies, upon the crura, and afterwards, in its tendinous portion, upon the dorsum, of the penis. The muscular part consists of opposite halves, each of which takes extreme origin from the ramus of the ischium, and is also attached to the surface of a crus, as it passes over the latter, and forms a spindle-shaped belly, that mounts the dorsum of the penis, just behind the border of the symphysis pubis, and, there becoming tendinous, joins the tendon of its fellow on the median line. After such union of the two muscular parts at nearly right angles with each other, the single delicate terete tendon so formed runs along the whole length of the dorsum of the penis, lying in the median line, to the bifurcation of the glans. There the tendon also forks or splits in two, and each half runs along the superior margin of the urethral groove of the glans, nearly to the apex of the latter. The important action of this singular muscle, although complicated, is evident. In the first place it has an effect very similar to that of the erector itself, in steadying and straightening, if not actually compressing, the crura. Next, when the penis is protruded backward, and stiff, the muscle causes the organ to point forward, by drawing upon it, until its apex swings around in the arc of a circle whose centre is at the end of the crura. Finally, the terminal splitting of the tendon enables the muscle to draw the forks of the glans apart, so as to insure the entrance of each into its own vagina; while the attachment of the tendons to the margin of the urethral groove dilates the latter, and facilitates the seminal discharge. The muscle is thus a director as well as a levator of the penis; and it is certainly very perfectly adapted to the purpose.

Erector penis.—Each crus is enveloped by a muscular tunic, very similar to those enfolding the capsules of the Cowperian glands. The erectors have no terminal fixed point of origin from the ischiatic ramus. The bony attachment of the muscle is by a fascia from the pubes, near the posterior margin of the symphysis, and distal extremity of the crus; the muscle is bulbous, or pear-shaped, as it were, being doubled upon itself by returning to near its point of origin after thickening and spreading over the crus, and firmly grasping the latter. It terminates by a stout, laminar tendon, upon the cavernous portion of the penis, close by the bulb. Its action is simple, direct compression of the crus, in much the same way as, *e. g.*, the uterus contracts upon its contents.

Retractor penis.—There is a pair of muscles for the special purpose of withdrawing the penis into the pelvis upon the subsidence of the priapism. These muscles are remarkably long and slender; being, when extended, some six or eight inches in length, with a width of only about an eighth of an inch, and a thickness of scarcely one-sixteenth. These attenuated slips arise muscular side by side from the anterior surface of the centrum of the last lumbar, or first sacral, vertebra, and passing along through the pelvis, diverge so as to pass one on each side of the rectum, to which they are imperfectly adherent by condensed cellular tissue. Leaving the rectum, and gaining the root of the penis by direct passage across the slight interval between these two points, they run along the sides of the body of the latter organ, and are finally attached muscular at the outside of the base of the glans, and somewhat upon the under surface, nearly opposite the point of bifurcation. Besides their proper office, these muscles have probably some action as reins or stays in guiding or steadying the penis whilst it is erect.

Accelerator urinæ.—As the corpus spongiosum, like the corpora cavernosa, has two crura, or begins as lateral halves, giving rise to separate urethral bulbs, this muscle likewise consists of two portions, which, however, meet and coalesce on the median line, beneath the roots of the penis, across which they run in a directly transverse course. The muscle, though small, is distinct; the two parts, each embracing and compressing a bulb, join across the urethra without a tendinous interval.

The thick and tumid prostatic part of the urethra, and also the thin anterior membranous tract, are both surrounded by well marked muscular fibre. The pairs of Cowper's glands are likewise invested, and very strongly, by separate, dense, bulbous muscles, serving for their compression.

Muscles of the Anterior Extremity.

It may be most natural, at any rate I find it most convenient, to consider under this head the muscles by which the anterior extremity is connected with the rest of the body, as well as those that lie wholly upon the member itself. Any division of the body into muscular "regions" is purely artificial; few muscles, comparatively speaking, lying and acting wholly within the limits so mapped out.

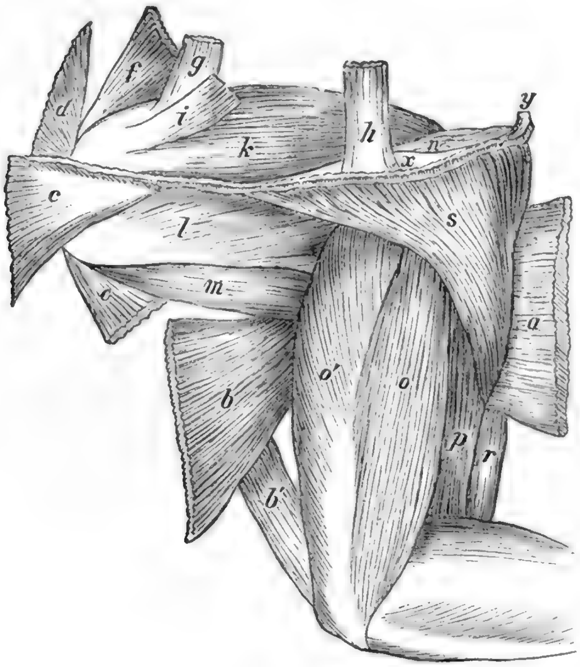


Fig. 28.—Muscles of right shoulder, about three-fourths natural size. (x, acromion; y, end of clavicle).

The anterior extremity is attached to the body by the sterno-clavicular articulation and fifteen muscles, distributed as follows:—To the clavicle two, cleido-mastoid and subclavius; to the scapula seven, trapezius, rhomboideus, serratus magnus, levator anguli scapulæ, omo-hyoideus, atlanto-acromialis,[1] and atlanto-scapularis;[1] to the humerus five, pectoralis major, in three divisions, latissimus dorsi, and dermo-brachialis; to the ulna one, epitrochlearis, a slip from the latissimus dorsi. These will be described in the order in which they are enumerated above.

Cleido-mastoideus.—Distinct in its whole length from the sterno-mastoid, but with a common origin; more terete and much smaller. It runs nearly straight downward from the mastoid to be inserted fleshy at the middle of the clavicle. Its course is oblique to that of the sterno-mastoid; its situation is superficial; it is in relation, externally, with the anterior border of the slip from the trapezoid.

Subclavius.—Of considerable size, and perfectly distinct from contiguous fascial or muscular structures; arises fleshy from the first rib near the sternal extremity, opposite the outer margin of the thoracic prolongation of the rectus abdominis, and proceeds obliquely outward to be inserted fleshy, into the distal extremity, of the clavicle, tip of acromion, and cleido-acromial ligament. Some of its fibres occasionally blend with those upon the under surface of the cleido-acromial muscle that lies upon the articulation.

Trapezius.—(Figure 28, *c*.) This muscle is extremely thin, but of great superficial area, forming a triangular plane that extends from the occiput to the last dorsal vertebra,

[1] These names may be alike unnecessary and unwarrantable; but, as explained further on, I have no alternative but to impose them, not knowing what, if any, names these two muscles may have already received. The muscle I call "atlanto-acromialis" may be the same as that described under the name "trachelo-acromialis," in, *e.g.*, the horse, where it is said by Owen to arise from the transverse process of the atlas and four successive vertebræ, and to spread over the acromial portion of the scapula, and descend as far as the middle of the humerus; but its disposition, in the opossum, is not strictly correspondent. The other, "atlanto-scapularis," may be morphologically the same muscle; but it is perfectly distinct in the opossum.

and curves around the shoulder to the middle of the clavicle, thus determining the contour of the side of the neck, as in man. It arises fleshy, or by a very short aponeurosis in some places, from the whole of the occipital crest, ligamentum nuchæ and spines and interspinous ligaments of all the cervical and dorsal vertebræ, overlying the rhomboideus and greater part of the latissimus. The upper fibres pass downward, outward and forward; the middle ones directly forward; the lower ones obliquely upward and forward; converging, in this manner, into a broad, flat tendon, that passes along and is attached to the scapular spine, acromion, and distal half of the clavicle. The aponeurosis plays freely over the root of the scapular spine; elsewhere it is intimately adherent to the fascial investment of the two spinati muscles, the deltoid and great pectoral. The muscular fibres themselves are not, however, continued directly into the pectoralis major, as is said to be the case with some marsupials (*e. g.*, *Perameles lagotis:* teste Owen, C. Anat. III., p. 11). The portion of the muscle that is inserted into the clavicle often, perhaps usually, forms a separate fasciculus that lies along the anterior cervical border, and is only united to the rest of the muscle near the side of the occiput. The part that lies over the protuberance of the shoulder is always extremely thin, and discontinuity of the plane at this point produces this clavicular slip.

Rhomboideus.—(Fig. 28, *d.*) There is no distinction of rhomboideus major and minor; the single muscle forms a continuous thin plane, overlaid by the trapezius, arising from the occipital crest and nuchal ligament next to the origin of the trapezius, and from the vertebral spines and interspaces as far down as the commencement of the latissimus, which is at a point just opposite the middle of the trapezius and the extremity of the scapula. It is inserted into the posterior border of the latter, fleshy, or with a very short aponeurosis, for nearly an inch. It draws the shoulder blade backward and upward.

Serratus magnus (fig. 28, *e*), and *Levator anguli scapulæ* (fig. 28, *f*).—The very large triangular plane of fibres that converges to be inserted into the posterior border of the scapula cannot be separated into two muscles except by arbitrary use of the knife. The upper fibres elevate, and the lower depress, the extremity of the bone; the whole acting together draw the shoulder directly forward upon the thorax. This arrangement, in all probability, relates to the animal's hugging of objects when climbing. The cervical or vertebral portion of the muscle, which is the levator, arises in slips from the posterior part of the transverse process of the four or five lower cervical vertebræ, more or less blended with the posterior scalenus. The thoracic or costal portion, which is the serratus, arises from the first eight or nine ribs, by as many fleshy digitations; beginning at the middle of the first rib, curving gradually towards the back-bone on successive ribs from above downward. The four or five lower slips are most distinct from each other, and interdigitate with the obliquus abdominis externus; they pass obliquely upward and backward; the upper ones directly backward; the latter are overlaid by the scalenus as low down as the fourth rib.

Omo-hyoideus.—(Fig. 28, *i.*) A broad, flat ribbon-muscle, arising fleshy from the side of the hyoid bone between the genio- and thyro-hyoid, and running downward a little way upon the sterno-thyroid; then curving away from the trachea, passing obliquely across the neck, underneath the sterno- and cleido-mastoid, above and beyond the shoulder to gain the *posterior* superior angle of the scapula, where it is inserted by a short, flat tendon, beside the insertion of the atlanto-scapularis. The extension of this muscle to the further end of the scapula at once augments its power, and causes it to become virtually a third elevator of the scapular angle. The omo-hyoid is a single simple band, with one curve in its whole length; it is not bound down and made to change its course by an aponeurotic loop; nor is it divided into two bellies by a central rounded tendon. But just where it passes the sterno-mastoid an imperfect, flat, tendinous intersection may frequently be found.

Besides the levator anguli scapulæ proper and the omo-hyoid, which acts as such, there are two other muscles, that proceed from the atlas to the scapula,—one to each extremity of the latter—and draw the bone directly upward. Not knowing what names they may have received, I shall describe them under the following ones: —

" *Atlanto-acromialis.*"—(Fig. 28, *h.*) A stout, flattish ribbon, arising by a slight tendon from the side of the ring and root of the transverse process of the atlas, passing downward (gradually widening as it descends), and a little obliquely outward, to be inserted fleshy into the root of the acromion and for half an inch along the under lip of the scapular spine. It lies superficial in the greater part of its extent, being only covered by the trapezius after passing the sterno- and cleido-mastoid. It pulls the scapula upward and somewhat forward.

" *Atlanto-scapularis.*"—(Fig. 28, *g.*) Similar in general characters to the foregoing; slenderer, more terete, longer, and with a more oblique line of traction. Its action upon the scapula is almost identical with that of the omo-hyoid. It arises from the apex and posterior border of the transverse process of the atlas, and is inserted into the plane surface at the posterior superior angle of the scapula; generally between the edge of this bone and the insertion of the omo-hyoid; but the relative insertions of the two vary somewhat. Teleologically, this muscle is a perfect "levator anguli scapulæ"; but it is not the muscle so named in anthropotomy; the latter existing, as we have seen, as the vertebral portion of the great plane of the serratus.

Pectoralis major.—(Fig. 28, *a.*) The first part of the pectoral is of only moderate bulk, although it arises from the whole length of the sternum, from tip of manubrium to xiphoid. It takes origin from the median line of the surface of the bone, and consequently in apposition with its fellow. Its upper corner overlies the insertion of the sterno-mastoid; but it has little, if any, origin from the clavicle. It is thinnest at its central part, where it overlies the second pectoralis,—the latter seeming, as it were, to be developed at the expense of this part of the major. It has an extensive insertion—into the whole length of the outer edge of the bicipital groove, as low down as the apex of the deltoid. The lower free border is much longer than the upper, and is folded smoothly under in an unusual manner; just as the collar of a coat is folded over, without any twisting of the fibres. This inflected portion is entirely separated from the rest of the muscle, except, of course along the line where it is turned under. It is the tendon of this inflected portion that is chiefly connected with the tendon of the dermo-brachialis elsewhere described. The upper portion of the muscle is much twisted. Those fibres that lie superficial at the manubrium do not proceed along the clavicular border of the muscle to the top of the bicipital groove, but are directed downward, so that their insertion is near the apex of the deltoid; while those that lie upon the deep surface opposite the second and third ribs, are directed upward, soon emerging to the surface, and are inserted into the upper part of the bicipital groove. The muscle has the usual action and lines of traction.

Pectoralis major, its second division.—The second or middle pectoral is the smallest of the three. It arises for about an inch and a half along the middle of the sternum, wholly covered by the first division. The fibres converge to produce a fan-shaped muscle that is inserted into the greater tuberosity of the humerus, and upper part of the outer lip of the bicipital groove. It abducts and anteducts the humerus, at the same time rotating the bone inward.

Pectoralis major, its third division.—Of large size, and the longest of the three, though thin and flat. It arises, in apposition with its fellow, from the linea alba for an inch or two below the xiphoid, narrowing rather suddenly to become a thin, slender ribbon that proceeds in a straight line obliquely forward and outward to be inserted, by a narrow, thin aponeurotic tendon, into the upper part of the outer edge of the bicipital groove close to the humeral tuberosity. Its insertion and action are nearly the same as those of the middle pectoral; it continues and augments the force of the latter. With its fellow, it forms a large V across the ventral aspect of the body, lying chiefly upon the thoracic prolongation of the rectus, and the scalenus, both of which it crosses obliquely. Its presence is of a part with the general preponderance of muscles that aid the flexion of the body and limbs over those that extend; it probably relates to the manipulation of the abdominal pouch and genitalia, in much the same way that has gained for the latissimus dorsi, in anthropotomy, the pseudonym of "scalptor ani."[1]

Latissimus dorsi.—(Fig. 28, *b*.) The great muscle of the back extends from the termination of the rhomboideus to the 3d and 4th lumbar vertebra. The aponeurosis of origin is narrowest above, where fleshy fibres reach nearly to the median line, and broadest over the loins; this tendinous lamina and the fleshy part of the muscle are both very thin. The upper border of the muscle is directly transverse; at first in relation with the rhomboideus, afterward with the teres. The lower or exterior border is very long; it proceeds obliquely forward and outward, presenting the usual twist by means of which it becomes the upper border of the tendon of insertion. The latter is an inch or more long, but scarcely a fourth of an inch wide; it is implanted in the humerus about an inch below the head of the bone, on the posterior or inner border of the bicipital groove, alongside, or a little above, the insertion of the teres.

Dermo-brachialis. (*Panniculus carnosus.*)—The large cutaneous body-muscle envelopes nearly all the back, side, and belly, with very extensive origin from the skin of the parts, meeting its fellow along the middle line of the belly, but separated, in most of its extent, over the back. It is properly a part of the panniculus of the head and neck already

[1] The pectoral muscle of another (a non-claviculate) marsupial, the *Perameles lagotis*, is thus described by Owen. (Comp. Anat. and Phys. III. p. 12):

"The pectoralis major is, as usual in the marsupial and many higher quadrupeds, a complicated muscle; it consists of an anterior or superficial and a posterior or deeper portion; the anterior portion receives the strip before mentioned from the trapezius, there being no clavicle or clavicular ossicle interposed in the Perameles; its fibres converge, increasing in thickness as they diminish in breadth, and are inserted into the anterior and outer part of the strongly developed pectoral ridge. The second and main portion of the pectoralis arises from the whole extent of the sternum; its fibres are twisted obliquely across each other as they converge to be inserted into the inner part of the pectoral ridge; some of the internal and posterior fibres of this portion of the twisted pectoral pass obliquely upward and behind the anterior fasciculi, and are inserted into the coracoid process, thus representing the pectoralis minor. Beneath this latter portion of the pectoral, a long and slender muscle passes to be inserted into the anterior part of the tuberosity of the humerus; this may likewise be regarded as a dismemberment of the pectoralis major, but it arises from the fascia of the rectus abdominis, below the cartilages of the lower ribs."

The three pectorals of marsupials recall the three of birds, and the suggestion is strengthened by the avian affinities that these animals and the Monotremes show. One might well be excused for taking the hint, at first blush of the question; but nevertheless it seems fallacious, the balance of evidence being decidedly the other way. If the three pectorals are really dismemberments of one, it is more than probable that what I have called "sterno-costalis" is really the true pectoralis minor.

described; but the latter is more or less distinct. Fibres converge from their radiation over the skin at large, to form a fan-shaped muscle, no longer adherent to the skin; the upper and lower borders of the muscle, after its separation from the skin, are in general relation, respectively, with the posterior borders of the latissimus and great pectoral. The muscle has definite insertion into the humerus along the outer border of the bicipital groove, by a very thin, wide aponeurotic tendon, more or less blended, in different instances, with the tendons of insertion of the pectorals. It retroducts the humerus, and appresses it to the side of the body; otherwise it is an adjuvant of the trunk muscles in curling up the body, when it takes fixed point of action from the humerus.

Omo-anconeus (*Dorso-épitrochlien* Duv.).—(Fig. 28, *b′*.) Two or three inches from the humerus the latissimus dorsi gives off from its under surface, near its lower border, a stout, flat, muscular slip, half an inch broad. This passes nearly at a right angle from the latissimus, along the inner surface of the scapular head of the triceps, past the elbow, to be inserted, by a definite tendon, into the ulnar olecranon, near the inner humeral condyle; and by a thin aponeurotic expansion blends with the general fascia of the forearm. Though of comparatively small size, this muscle, from its very advantageous line of traction, is a powerful adjuvant of the latissimus in retroducting the arm, and of the triceps in extending the forearm. The design appears to be increase of power of curling the body, as, *e. g.*, around limbs of trees, etc. Although here appearing as actually only an offset from the latissimus, it presents itself as really the homotype of the sartorius of the pelvic extremity. It is the same as that described by Duvernoy in the Gorilla as "dorso-épitrochlien." There is no attachment of this muscle by aponeurosis, or otherwise, to the scapula or thorax.

The articulated parts of the scapular arch are joined together by a small muscle devoted exclusively to this purpose, in addition to the usual joining by the indirect action of the trapezius and deltoid. From the scapula five muscles act upon the humerus, and three upon the forearm; from the clavicle none proceed to the arm except part of the deltoid. The muscles about the shoulder itself have much the same situation, shape and action as in man; but there is no teres minor. The coraco-brachialis is extremely small. There is one (tricipital) extensor cubiti, and three flexors, the biceps being divided and inserted in an interesting manner.

Cleido-acromialis.—(Fig. 28, *n*.) A small muscle, distinct from the supraspinatus, and almost, if not wholly, from the subclavius. It arises, by an aponeurotic tendon that becomes fused with the fascia over the supraspinatus, from the acromion and proximal half of the scapular spine; runs transversely across the top of the shoulder, and along the corresponding half of the clavicle, strengthening and protecting the loose, weak acromio-clavicular articulation. Sometimes its under surface is somewhat blended with the termination of the subclavius; but it cannot be regarded as an extension of that muscle. I do not know what name it may have already received.

Subscapularis.—The want of convexity of the scapula causes this muscle to be thin and flat. It arises from the periphery and greater part of the thoracic surface of the bone, and is broadly inserted into the lesser tuberosity of the humerus, rotating the latter inward, and thus directly antagonizing the infraspinatus. Its short, thick tendon passes across the shoulder-joint, between the latter and the coraco-brachialis; an aponeurosis radiates upon the thoracic aspect of the muscle, much as in man; many fleshy fibres take origin from this fascial investment.

Supraspinatus. — (Fig. 28, *k.*) The muscular portion fills the whole fossa to the level of the spine, and bulges above the upper border of the bone. Much of the insertion into the top of the greater tuberosity is fleshy; the short, thick, tendinous part is in intimate relation to the joint. The muscle has the usual action.

Infraspinatus. — (Fig. 28, *l.*) Larger than the preceding, in consequence of the position of the scapular spine, but with the same general characters. The insertion into the lower part of the great tuberosity is almost entirely fleshy, and more or less blended with that of the foregoing. The muscle everts the humerus, directly counteracting the subscapularis. No teres minor can be demonstrated as distinct from the rest of the fleshy mass filling the infra-spinal fossa.

Teres major. — (Fig. 28, *m.*) Arises fleshy from the posterior inferior angle of the scapula, and proceeds along the lower border of the bone, in relation with the upper border of the latissimus dorsi. It is a stout, subcylindrical muscle, passing inside the scapular head of the triceps, to be inserted by a short, thin ribbon-tendon into the inner or posterior edge of the bicipital groove, a little below and behind (sometimes opposite) the insertion of the latissimus, with the tendon of which, however, its tendon is not conjoined. It draws the humerus directly backward, and to a less degree rotates it inward.

Deltoid. — (Fig. 28, *s.*) Large in superficial extent, but of only moderate thickness. It is thinnest along its origin and where it passes over the tuberosity of the humerus; thicker along either border. It arises from nearly the whole of the scapular spine, acromion, acromio-clavicular ligament, and outer part of the clavicle, as far as the insertion of the cleido-mastoideus, fleshy from the clavicle, but by a very short aponeurosis, more or less blended with the fasciæ over the trapezius and infraspinatus, along the rest of its extent. From this wide origin fibres converge to a point, to be inserted fleshy into the prominent, roughened tubercle on the anterior face of the humerus, midway between the extremities of this bone. It has the usual actions and lines of traction; its texture is rather coarser than that of surrounding muscles. It covers the shoulder-joint and upper part of the humerus, and overlies, in intimate relation with, the upper part of the great pectoral on the one side, and the origins of the brachialis anticus and outer humeral and scapular heads of the triceps on the other. The tendons of the pectorals separate it from the biceps.

Coraco-brachialis. — This muscle, though very small, is not by any means rudimentary. It is about an inch long, tendon and all, and rather stout for its length. It arises by a slender tendon from the tip of the coracoid, forms a spindle-shaped belly, lying directly on the head of the humerus, from which it is separated by the tendon of the subscapularis, passing across the latter, alongside the coracoid head of the biceps, to be inserted fleshy into the humerus just at the origin of the inner humeral head of the triceps, of which it appears almost like a direct upward prolongation. Its action must be very feeble.

Biceps. — (Fig. 28, *r.*) This muscle is remarkable in several respects. It is "biped," rather than bicipital; the division of the two portions almost makes two distinct muscles; one goes to the radius, as usual, the other to the ulna. As a whole, the muscle arises from the upper margin of the glenoid fossa, the tip of the coracoid, and the intervening notch. While this tendon of origin is not completely separable into two parts without some laceration of sclerous fibre, it really consists of two differently shaped portions. But neither of these parts enters the capsular ligament of the shoulder-joint; so that it is a question whether the true glenoid or "long head of the biceps" really exists; the part that is found, though thus incompletely divisible into two portions, may be in fact only the coracoid, or "short head," which reaches to the margin of the glenoid across the intervening notch, only in consequence of the small size and sessile condition of the coracoid. That part that goes to the glenoid is thick and terete; the rest is thin and flat. An inch or so below the origin the two parts separate; these two fleshy bellies do not afterward reunite. The muscle from the flattened coracoid tendon is the larger of the two, and presents externally the appearance of a stout fusiform belly; but internally it is scooped or fluted, as it were, forming a longitudinal depression in which lies the slenderer, more terete, or spindle-shaped belly that comes from the glenoid tendon. The large coracoid muscle suddenly diminishes in calibre as it dips down between the pronator radii teres and the extensor bundles on the forearm, and passes to the usual insertion, by a stout rounded tendon, into the tuber radii. The smaller glenoid part accompanies the other into the cleft between the muscles on the forearm; but it is inserted into the base of the coronoid process of the ulna. I have no idea what useful purpose is subserved by this construction of the chief brachial flexor, but it may convey a hint as to its morphological relations.[1]

Brachialis anticus.—(Fig. 28, *p.*) The "short" flexor of the forearm does not lie entirely upon the front of the humerus, nor bifurcate above to enclose the apex of the deltoid. It arises from the outer surface of the bone, especially along the slight elevation that marks the upward prolongation of the external condylar ridge, passing obliquely around the insertion of the deltoid to gain the front. Fibres take origin from the middle third of the humerus, part of the upper third, and nearly all the broad intercondylar surface. The muscle dips down between the bundles upon the forearm, alongside the tendon of the biceps, to be inserted with the latter into the coronoid process of the ulna.

Triceps.—(Fig. 28, *o*, outer humeral, and *o'*, scapular, head.) The single cubital extensor is of great size, and has extensive attachments. It is only incompletely divisible into three heads; the scapular head alone is perfectly distinct from the others, but representing the middle division of the muscle it serves to partially separate the two humeral portions. This long head arises from the inferior border of the scapula for half an inch or more beyond the glenoid fossa; its fibres at first pass straight downwards, but afterward more obliquely, converging to the common great tendinous intersections. The other two heads, blended together, conjointly take origin from nearly the whole of the posterior aspect of the bone between the brachialis anticus and teres above, and condylar ridges below. There are tendinous laminæ in the muscular substance, which separate the scapular from the humeral heads; but the chief one is that running some distance up the posterior surface of the muscle, as in man. The inner humeral head is the shortest; it is inserted, together with the scapular, into the olecranon itself; the outer head is longer as well as

[1] This arrangement of the biceps, which I have verified by repeated dissections, differs much from that given by Owen (Comp. Anat., iii, p. 12) as occurring in another marsupial—the *Perameles*. This author says: "The *biceps* is a powerful muscle, although its short head from the coracoid process is suppressed. The long head has the usual origin and relation to the shoulder joint; its tendon is very thick and short. The fleshy belly joins that of the strong brachialis internus [qu. anticus?] situated at the external side of the humerus, whence it takes its principal origin from the short deltoid ridge, closely connected there with the second portion of the triceps, and deriving some fleshy fibres from the lower and outer third of the humerus. The portion of the biceps arising by the long head soon resolves itself into two distinct penniform muscles; the tendon of the outer one joins that of the brachialis, and this conjoined tendon simply bends the forearm, while the inner tendon bends and pronates; the latter, which is a direct, though partial, continuation of the biceps, is inserted into the ordinary tubercle of the radius; whereas the outer tendon is attached to the fore part of the proximal end of the ulna."

larger, and is inserted, moreover, into the outside of the shaft of the ulna for nearly an inch below the olecranon. Some fibres of the conjoined triceps tendon are continuous with the slip from the latissimus dorsi, and the fascia of the forearm.

The forearm is very like our own in contour; pronation and supination are perfect; and almost all the muscles of anthropotomy are present, with much the same relative size, shape, position and action; certain of them, however, differ a little in their insertion. No marsupial, perhaps, has a more perfect "hand" than the opossum. The fingers are very mobile, and the thumb perfectly opposable. The most notable muscular absentees are the extensor secundi internodii pollicis, and the flexor longus pollicis.

In the supine forearm three muscular regions, containing as many sets of muscles, may be conveniently, if artificially, distinguished. First, the *radial*, containing the long and short supinators, and long and short radial wrist extensors; second, the *anterior brachial*, containing the round and square pronators, sublime and profound digital flexors, and long palmar; third, the *posterior brachial*, containing the ulnar wrist extensor, common digital extensor, extensor of little finger, extensor of index and first pollical internode, and extensor of pollical metacarpal. Notwithstanding the number and variety of the extensors, the flexor system, as usual, greatly preponderates in power.

Fig. 29.—Muscles of the right forearm, anterior surface; natural size.

Supinator longus. — (Fig. 29, *g*, and fig. 30, *a*.) Largest of the four muscles of the region, arising highest up on the condylar ridge, and mainly determining the contour of the parts. A somewhat flattened spindle with thick fleshy origin, narrowing midway or at the lower third, to a rounded tendon that passes over the head of the radius to be inserted into the corresponding side of the wrist.

Supinator brevis.—There is no large muscle curving over the upper third of the radius from the humeral condyle and ridge of the ulna, as in man. The homologue of the short supinator is found in a small, slender fasciculus, about an inch long, that arises from the outer condyle, or rather from the contiguous part of the joint-ligament, in intimate relation with the head of the radius, and lies upon, and is attached to, that bone, as far down as the insertion of the pronator radii teres. It has a fascial investment, and is perfectly distinct from the superincumbent muscles.

Extensor carpi radialis "longior."—(Fig. 29, *h*, and fig. 30, *b*.) Arises from the external condylar ridge next below, and partly overlapping the S. longus, lying in its whole length between this and the muscle next described. It bears the same general characters as the long supinator; its tendon passes, in company with the tendon of the latter, along a groove over the head of the radius, and is inserted into the base of the index metacarpal.

Extensor carpi radialis brevior.—(Fig. 29, *i*, and fig. 30, *c*.) As long as the preceding and rather larger, with a stouter, flatter tendon. It arises lower down on the condylar ridge, and from the condyle itself; it lies alongside the preceding; its tendon occupies the same groove in the radius; it is inserted into the base of the middle metacarpal.

Fig. 30.—Muscles of the right forearm, posterior aspect; natural size.

Pronator radii teres.—(Fig. 29, *a*.) A large, flattened muscle arising fleshy from the internal condylar ridge as high up as the foramen; with no ulnar origin; crossing obliquely past the brachial flexors to gain the radial side, to be inserted by a broad aponeurosis into the middle third of the radius. The usual action.

Pronator quadratus.—(Fig. 29, *c*.) Well developed, with the usual shape, situation and action. It is restricted to the lower part of the arm, instead of extending it to the elbow, as in some marsupials.

Flexor carpi radialis.—(Fig. 29, *b*.) A somewhat flattened spindle, arising from the inner condyle next below the round pronator, which it separates from the digital flexors; its origin is blended with that of the latter. Its slender, round tendon, nearly or quite as long as the fleshy part, runs over the head of the radius, to be inserted into the base of the index metacarpal.

Flexor carpi ulnaris.—(Fig. 29, *d*.) A bi-pinnatifid muscle, larger than either of the foregoing, and, like the long supinator, mainly determining the contour of the part. The posterior vane is larger than the other, and continues fleshy almost or quite to the insertion; the anterior one is only two-thirds as long, so that the stout tendon occupies part of the anterior border of the muscle. The muscle arises from the internal condyle, the corresponding face of the olecranon, the upper half or two-thirds of the edge of the ulna, and the intermuscular septum between itself and the digital flexors. Its tendon passes over the head of the ulna to be inserted into the most prominent bone of the carpus on the ulnar side (pisiform), besides giving off fibres that are continuous with the annular ligament and the general fascia of the parts. The ulnar nerve runs along the inner surface of the muscle.

Palmaris longus.—(Fig. 29, *e*.) This is a slender fusiform muscle lying between the last described and the digital flexors, with both of which it appears intimately blended, but may be traced as a distinct fasciculus to the condyle. Its long, slender, round tendon passes a little obliquely outward over the digital flexors, gains the middle of the front of the wrist and there spreads out into the palmar fascia, being specially attached, on the radial side, to the cartilaginous spur that lies appressed upon the ball of the thumb, and correspondingly on the ulnar side, to the pisiform bone. This attachment on the ulnar side, did not, in any of the specimens examined, show transverse muscular fibres corresponding to the "palmaris brevis" of anthropotomy. The concavity of the wrist is thus arched over by a fibrous band attached to the most prominent point on the radial and ulnar side. The tendons of both digital flexors pass underneath this bridge; being further bound down, however, by a proper annular ligament.

Flexor digitorum communis sublimis s. perforatus and *Flexor digitorum communis profundus s. perforans.*—(Fig. 29, *f.*) In the hand the tendons of the two sets of digital flexors are perfectly distinct, and have precisely the characters of the human perforans and perforatus. But in the arm the muscular parts are so much blended that they cannot be separated without rather forcing the dissection; their connection with the radial and ulna wrist flexors, on either side, is also intimate. The fleshy portions are therefore most conveniently to be considered together. The large mass of muscle occupies the whole of the front of the forearm between the two wrist flexors, with very extensive origin from both bony and fibrous surroundings. Of the part that chiefly represents the deep flexor, an inner portion arises from the olecranon and upper two-thirds of the back of the ulna; an outer (the most distinct one) from the extremity of the inner condyle of the humerus; and a middle, from the upper half of the back of the radius, interosseous membrane and contiguous surface of the ulna. The part that represents the superficial flexor arises from the lowest and back part by the condyle and the contiguous part of the joint ligament.

Imbedded in this fleshy mass lies a slender little spindle of muscle, quite distinct from the rest. It may be traced entire to its origin from the very edge of the ulnar articulating surface of the humerus. Its delicate tendon is lost in the common bundle of the conjoined deep flexor tendons; at least I did not succeed, after several dissections, in tracing it to a digit. It seems to be the flexor longus proprius pollicis, arrested on its way to the thumb. It will be shown below that the tendon of the proper long flexor of the great toe is similarly attached to the common flexor of the toes.

The tendons of the profound digital flexor are five in number — the thumb being supplied like the other digits. They are not separated until the muscle has passed the wrist, being indissolubly bound together into one stout, flattened band, and enjoying no individual motion. This dense fibrous band cannot be split into five tendons without arbitrary use of the knife. It fills the concavity of the front of the wrist, where it is bound down by a very distinct annular ligament, different from the simple bridge formed by the palmaris longus, and so long as to be properly called a sheath. After separating on the palm, the tendons pass to the fingers as stout, flattened bands, and proceed to be inserted into the base of the ungual phalanges. In the palm, they are bound down by the palmar fascia; as they pass along the second phalangeal internode each is bound down by a small but very distinct, stout, transverse fibrous band.

The accessory muscles (*lumbricales*) of the deep flexor tendons are well developed. They are four in number, the thumb having none. They arise from the radial side of the tendons at the point of separation of the latter from each other; and sometimes further up on the conjoined tendon. They have some fascial connection with the superficial flexor tendons. The four little fasciculi are perfectly distinct from each other; they are inserted on the radial sides of the bases of the four fingers, or rather into the fibrous sheath that envelopes the fingers.

The sublime flexor tendons are four in number, the thumb not being supplied; extremely slender and delicate, like silken threads, somewhat liable to be overlooked or destroyed, unless carefully sought for. In passing the wrist they are confined by the annular ligament, but are not included in the single large tendinous bundle just described. Contrary to what is the case with the deep flexor tendons, these superficial ones may be easily separated from each other as high up as the muscular part, or even further. After reaching the fingers each one splits, as in man, to embrace a deep flexor tendon; the forked extremity is inserted into either side of the base of the second digital phalanx. The tendons are also slightly bound down where they pass the bases of the fingers.

Extensor digitorum communis.—(Fig. 30, *d.*) Proceeding down the external condyle, we find the origins of three muscles appertaining to the posterior brachial region, besides the three of the radial region already described. They are superficial, and pass straight down the forearm; the other muscles upon the back of the forearm are deep seated and oblique in direction. The common digital extensor is the first of this superficial set, arising from the external condyle next below the extensor carpi radialis brevior, and lying between this muscle and the proper extensor of the little finger. It is incompletely divisible into two parts; one for the index and middle, the other for the ring and little fingers; but all four tendons can be separated high up on the arm. The four separate from each other upon the back of the wrist, and each one proceeds to be inserted into the back of the base of the ungual phalanx of a finger. As they pass the bases of the fingers all are bound down by, or rather spread on either side to help form, the fascia of the parts.

Extensor minimi digiti.—(Fig. 30, *e.*) Perfectly distinct from the foregoing, with which it agrees in shape, but is rather smaller. It arises next below on the external condyle, from the extreme anterior point of the latter. Its extremely delicate tendon runs alongside that of the preceding to the same insertion, and is sometimes virtually, if not actually, blended with it. Before reaching the finger it frequently gives off a filamentous slip that joins the extensor tendon of the annularis.

Extensor carpi ulnaris.—(Fig. 30, *f.*) Scarcely larger than either of the preceding; lying superficial along the edge of the ulna, arising from the lowest point of the external condyle and contiguous part of the joint, and for a short distance from the ulna itself, becoming tendinous midway, running along a slight groove in the head of the ulna to be inserted into the base of the fifth metacarpal.

Extensor indicis (et pollicis).—(Fig. 30, *g.*) Proper extensors of the first and of the second pollical internodes do not exist; but the extensor of the fore finger has two perfectly distinct tendons, one of which goes to the thumb and supplies the place of the extensor secundi internodii pollicis. The muscle lies deep seated on the shaft of the ulna, covered by the ulna carpal extensor, and is small and inconspicuous. It has no condylar origin, arising from the upper half or third of the ulnar crest. Its two long, delicate tendons gain the radial side by passing diagonally across the lower third of the forearm, underneath the digital extensor tendons. One (ib. *g''*) runs along the back of the forefinger to the base of the ungual phalanx, side by side with the index tendon of the common extensor, and virtually, if not actually, blended with the latter. The other (ib. *g'*) passes still more obliquely to gain the thumb along the back of which it runs, to be inserted into the base of the distal phalanx. This thread-like tendon is the only extensor of the pollical internodes.

Extensor ossis metacarpi pollicis.—(Fig. 30, *h.*) This muscle is of great size, as if to compensate for the want of other thumb extensors. It is the most deep seated of all the extensors, but its tendon speedily becomes the most superficial of any, overlying the tendons of the supinator longus and the two radial wrist extensors in its oblique passage across them to gain, and be inserted into, the base of the first metacarpal. The muscular part is pinnatifid, two or three times as long as the tendinous, lying flat upon the radius and ulna, and taking extensive origin from both these bones, as well as from the interosseous septum. On one side fleshy fibres extend nearly to the wrist; on the other the tendon runs higher up. The tendon is very stout and flat, and gives off fascial expansions on either side.

———— ? There is one other muscle upon the forearm that may or may not be considered as the representative of the anconeus. It is a short, stout little bundle of fibres that passes transversely across the inner aspect of the convexity of the elbow, from the inner condyle to the olecranon, filling up the notch or gap that would otherwise be apparent between these two salient points. I make it out to be perfectly distinct from any of the muscular surroundings. Its action must be feeble and very limited.

The remarkable muscular similarity of the opossum's arm to that of man, as indicated by the muscles just described, is carried out to a surprising extent by the little muscles proper to the hands. The palm is very fleshy; there is a well developed "ball" upon the thumb, and a corresponding massa carnea along the ulnar border, in both of which substantially the same muscles that are found in man may be demonstrated. In addition to these, and to the lumbricals already noticed, there are two sets of interossei—palmar and anconal. The fingers are freely movable in all directions, and the palm may be hollowed from side to side, as well as closed in the ordinary way.

Adductor pollicis. Adductor minimi digiti.—On stripping off the flexor tendons and lumbricals, we come upon a broad, thin plane of transverse muscular fibres, resting upon the palmar interossei, and covering the whole palm. This has a median raphé, along the whole length of the third metacarpal, from which and from the carpal bone that the latter articulates with, the muscle takes origin. Passing across the hand, on either side from the median line, the fibres converge to be inserted into, respectively, the inner side of the the phalanx of the thumb and of the little finger, forming the two muscles whose names head this paragraph. They contract the palm from side to side.

Abductor pollicis. Flexor brevis pollicis.—A large flattened mass, forming the chief bulk of the ball of the thumb, arising from the trapezium, annular ligament, base of metacarpal, and inner surface of the appressed cartilaginous spur, and inserted into the base of the first phalanx of the thumb, beside the preceding. A few fasciculi may be demonstrated as partially distinct, though with much the same origin and insertion. These represent the short flexor.

Opponens pollicis.—A small fusiform muscle, perfectly distinct from the preceding, lying upon the extreme radial border of the hand, in intimate relation with the tendon of the flexor ossis metacarpi pollicis, along the first metacarpal; inserted into the outside of the base of the first pollical phalanx.

Abductor minimi digiti.—Similar to the corresponding muscle of the thumb; arising from the pisiform bone, lying along the ulnar side of the fifth metacarpal, and inserted into the outside of the base of the first phalanx of the little finger. A true flexor brevis is scarcely or not demonstrable as distinct.

Opponens minimi digiti.—Occupying the extreme ulnar margin of the hand, this small muscle proceeds to the same insertion with the foregoing. It arises from the pisiform bone and annular ligament.

In the arrangement of these muscles of the lateral digits it is to be noticed, that the thumb and little finger are each adducted and flexed by a broad plane of fibres proceeding from the median line of the hand; that each is abducted and extended by a more external bulging mass of fibres. The flexores breves may be lost in the inner part of these last named fibres; and the opponentes be more or less blended with the outer part of the same.

Interossei.—The palmar are of large size, lie upon the metacarpals rather than between them, and are much blended together, forming a fleshy mass that completely fills the concavity of the palm. They seem rather to flex the fingers than to produce lateral movements; but when the fingers are fully extended, they may aid in spreading them apart. There are four dorsal interossei perfectly distinct from each other, lying between the bones. Each is pinnatiform, arises from contiguous sides of two metacarpals, and is inserted into the radial side of the base of a finger.

[NOTE. In the long interval between the preparation and publication of this Memoir, we have adopted for the muscles that act upon the carpus and metacarpus the necessary change in nomenclature proposed by WILDER (*these Memoirs*, I, 1865, p. 32), by which the so-called "flexors" become *extensors*, and the so-called "extensors" become *flexors*. As the change cannot now be readily made, the muscles are here presented under their usual names, with this explanation of an apparent discrepancy between our determinations in the present instance, and those published for Man (*N. Y. Medical Record*, July, 1810) and for the Ornithorhynchus (*Proc. Essex Inst.*, VI, 1871, p. 152), (— see, however, the concluding Part of this Memoir).]

MUSCLES OF THE POSTERIOR EXTREMITY.

The pelvic arch, unlike the scapular, being immovably connected with the body, is primarily acted upon by but few muscles; and those that pass from the body to the femur are not many. Those that, though really attached in some way or another to the pelvis, act not upon, but from it, are all considered in other connections, with the exception of the psoas parvus, which is most conveniently described here: they are the perineal and abdominal muscles, part of the vertebral series, and two special caudal muscles, the ilio- and ischio-coccygeus. Two other caudal muscles, acting upon segments of the pelvic appendage, most properly come under the present head.

In consequence of extreme elongation and narrowness of the haunch bones, their over- and under-lying muscles have rather unusual configuration. The six small muscles collectively known in anthropotomy as "rotatores femoris," are all present and well developed. There is a small muscle upon the hip joint not found in man. There is no tensor vaginæ femoris; no cruræus or subcruræus can be demonstrated.

Psoas parvus.—(Fig. 31, *c.*) This muscle is well developed, being nearly as large as, and much longer than, the psoas magnus. It arises fleshy from the bodies of all the lumbar vertebræ, except the uppermost one, forms a stout conical belly, contracting opposite the top of the ilium into a slender, flat tendon that is inserted into the horizontal ramus of the pubes, nearly in front of the acetabulum, at a point just above and outside the articulation of the marsupial bone. The tendon is dense and shining; above, it spreads on the ventral surface of the muscle; below, its edges and insertion are defined with remarkable sharpness.

Psoas magnus.—(Fig. 31, *b*, and fig. 32, *n*.) A stout pyriform muscle, partially pinnatiform, arising fleshy from the sides of the bodies and the transverse processes of two or three lumbars next above the top of the ilium, and the two sacral vertebræ. It is inserted by a stout rounded tendon into the trochanter minor, blending more or less with the tendon of the iliacus. Fleshy fibres continue almost to the insertion on the posterior aspect of the muscle; on the anterior, a tendinous expansion reaches half way up.

Iliacus.—(Fig. 32, *m*, and fig. 31, *a*.) A rather narrow, elongated and slightly curved muscle, arising from the tip and expanded face of the bone, between the psoas and glutæus mimimus; the usual insertion, by a flattened tendon, with the preceding, into the trochanter minor. Flexion and outward rotation of the thigh, as usual.

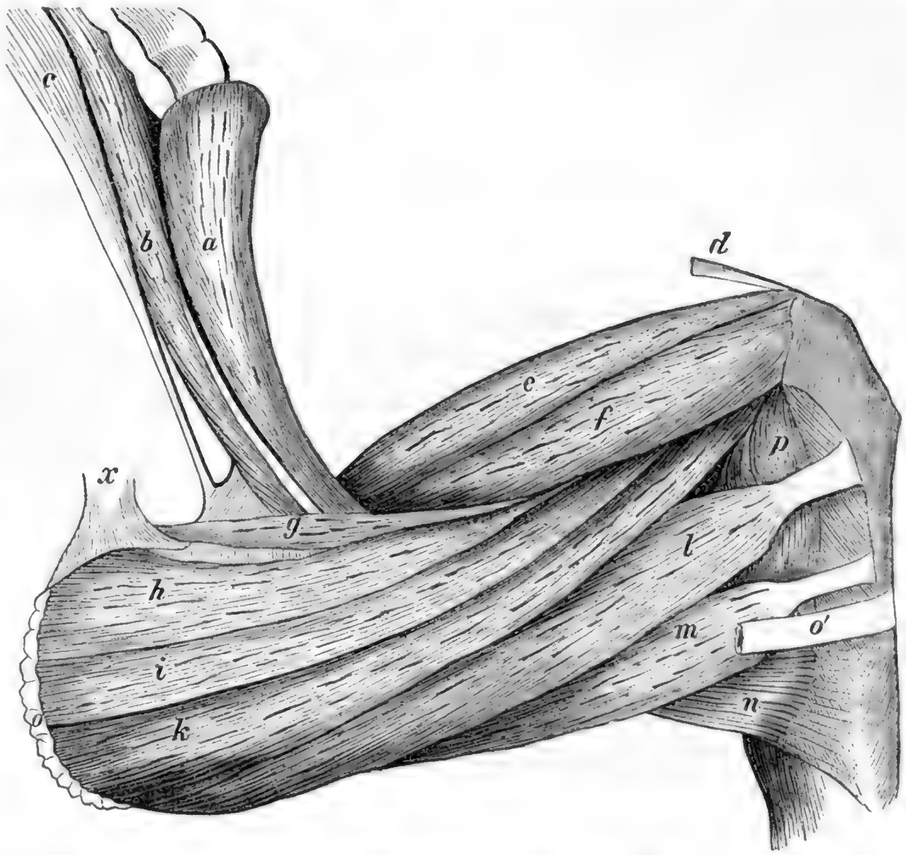


Fig. 31.—Inner aspect of left leg — thigh flexed, rotated inward and strongly abducted, so that the iliacus and psoas muscles are brought nearly in the same plane; nearly natural size. *x*, the os marsupiale.

Glutæus maximus.—(Fig. 32, *k*.) Remarkable for its great superficial extent, and at the same time for its extreme thinness. Its ordinary character, as a fleshy "mass," is changed to that of a layer muscle; its texture is not very appreciably coarser than that of surrounding muscles; nor is it divided into bundles by inward prolongations of the fascia covering it. It forms a wide-spread, thin plane, arising from the tip of the ilium, and by a broad aponeurosis (the fascia over the caudal extensors) from thence to a point of the vertebral column opposite the tuberosity of the ischium. Its anterior border is, as it were, tucked under, and continuous with the glutæus minimus, by complete blending of muscular fibres. The relation of its posterior border to the femoro-coccygeus is described below. From such broad origins the muscle converges, fan-shaped, to the trochanter major, passes over the latter, and is inserted into the ridge on the back of the femur for an inch (and sometimes much more) below the head of the bone. The line of traction of this muscle makes it only a feeble extensor of the thigh; it chiefly abducts and everts.

Glutæus medius.—(The dotted line in fig. 32 shows the extent of the muscle.) This is the most bulky of the three. It arises fleshy from the dorsum of the ilium (all that part not occupied by the succeeding), and by aponeurosis from a corresponding extent of the vertebral column, separating the lateral caudal extensors. It is inserted into the apex of the great trochanter, between the other two glutæi, by a short, stout, flattened tendon. It flexes, abducts, and inverts the thigh.

Glutæus minimus.—(Fig. 32, *l.*) Smallest and most anterior of the three; the only one that arises wholly from the ilium. It takes origin from the common tendon at the tip of the ilium, from the prominent ridge along the anterior border of the bone, and from the flat expansion of bone inside this ridge near the head of the femur. Its anterior border meets and blends with that of the glutæus maximus, thus enclosing the medius, and is in apposition with the iliacus. It has an extensive insertion into the apex of the great trochanter; its action is much the same as that of the foregoing.

Femoro-coccygeus.—(Fig. 32, *h.*) In the course of numerous dissections I have found considerable variation in this muscle—if it really be a distinct one. Sometimes it is scarcely demonstrable as distinct from the glutæus maximus; its aponeurosis of caudal origin being directly continuous with that of the glutæus; its fibres lying in precisely the same plane; its anterior border scarcely separable from the posterior border of the glutæus; its femoral insertion appearing like a direct continuation, along the bone, of the glutæal insertion. In such cases it expends itself upon the femur without reaching the head of the tibia, or, at most, only a fascial or aponeurotic extension attains the knee. When most distinct it is separated by a delicate fascia, or a cellular interspace, from the posterior border of the glutæus; and near its origin its fibres may not lie quite parallel with, or even may overlap, those of the glutæus. It then proceeds, with little or no proper attachment to the femur, to the leg; its posterior border runs along the upper border of the biceps; its crural insertion is by a broad aponeurosis, common to it and to the biceps, into the fascia over the leg, just below the knee. The muscle is always flat and very thin; at its origin it may be an inch or more broad; it narrows before passing the trochanter, and in the rest of its extent it is only a third or a fourth of an inch wide. It extends the thigh and flexes the leg; secondarily, it subserves somewhat to the lateral motion of the tail. Either this muscle, or the one below described as "cruro-coccygeus," is the homologue of what is called the "musculus accessorius a caudâ ad tibiam tendens," in the *Ornithorhynchus*.

Pyriformis.—This muscle is of comparatively large size, and has the shape that has given it its name in anthropotomy. It is covered by the glutæus medius, appearing just under the posterior edge of this, when the maximus is reflected. It arises from the transverse processes of two or three vertebræ, immediately following the synchondrosis, running obliquely outward and backward across the sciatic notch and body of the ilium, in front of the origin of the ischio-coccygeus, and across the hip joint, to be inserted into the very apex of the trochanter major, in intimate relation with the tendon of the glutæus medius, but distinct from that of the obturator internus.

Quadratus femoris.—Of much the same shape and relative size as in man, arising from the ischium next above the adductor, with a broad, fleshy insertion into the back and lower part of the trochanter major, and smooth space between this and the trochanter minor. It extends and everts the thigh.

Obturator externus.—Much larger than the other; a thick rounded muscle, corresponding to the contour of the ischium and pubes, occupying the surface of the bone and foramen. It is inserted by a stout, narrow tendon, somewhat terete, into the lower part of the digital fossa.

Obturator internus.—A thin plane of fibres, rounded in contour, occupying and arising from the whole inner face of the bone, and obturator membrane. Its tendon, which has decided traces of the peculiar digitated structure so beautifully shown in our own, curves around the border of the ischium, just in front of the ischio-coccygeus, and, receiving the gemelli, proceeds to be inserted into the digital fossa.

Gemelli.—The accessory muscles of the foregoing are well developed, lying along either border of the tendon, distinct from each other above, blended together below. They arise from the edge of the ischium, and are inserted into the tendon near the insertion of the latter.

Ilio-femoralis.—(*Scansorius* Traill.) Besides the preceding six little muscles about the hip joint, there is another and very curious one. It is a small, very slender fasciculus, arising from the upper border of the acetabulum alongside the origin of the rectus, running straight down over the front of the joint, and there curving a little inward to gain, and be inserted into, the base of the trochanter minor. It thus lies in precisely the position of that anterior longitudinal ridge, produced by thickening of the capsular ligament, known in human anatomy as the "ligamentum ilio-femorale." In the present instance this ligamentous ridge does not exist. It is undoubtedly the same muscle as that described by Traill in the ape, under the name of *Scansorius*.

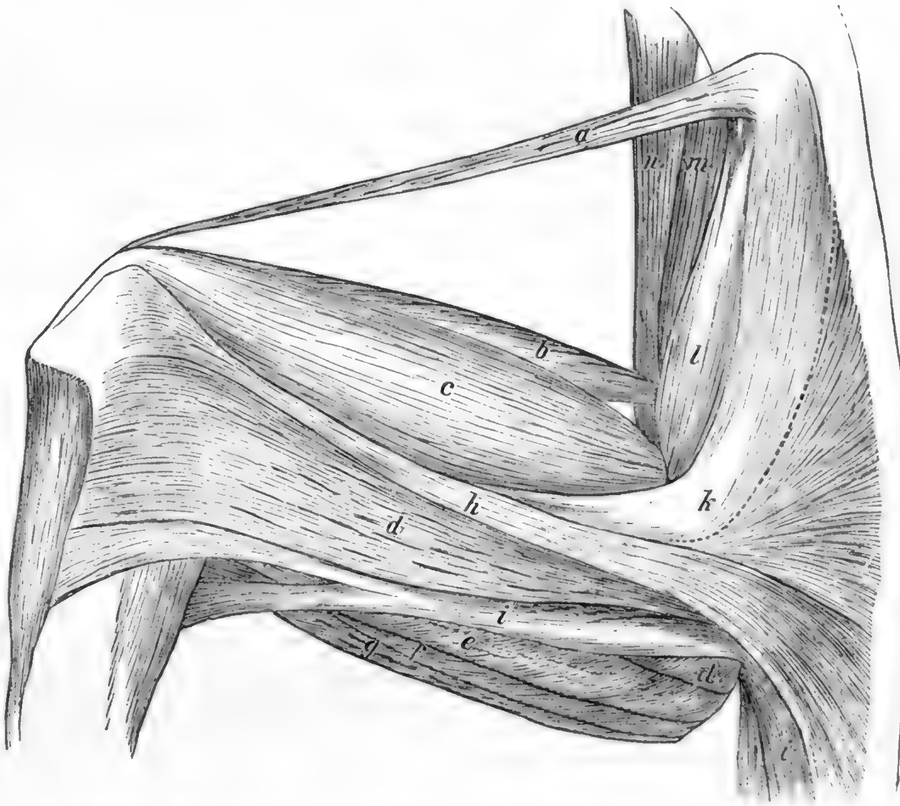


Fig. 32. — Muscles of the left leg, outside — about four-fifths natural size.

There are four flexors of the thigh and extensors of the leg—the sartorius, rectus, and two vasti; and, likewise, four proper extensors of the thigh and flexors of the leg — the gracilis, semitendinosus, semimembranosus and biceps. To the latter, however, must be added the femoro-coccygeus, when fully developed; and also the muscle below described as the cruro-coccygeus. The last named divides into two distinct slips, with opposite insertions in the leg; so that there are really seven leg-flexing tendons that come down along the back of the thigh. The remarkable disposition of these is shown in the accompanying figures. Great flexing power is insured by their low insertions; and rotation of the knee is subserved by their peculiar relation to each other. There are three adductors, which, however, act chiefly as extensors, and a pectineus, which is really an adductor. The contour and disposition of all the muscles is such that the thigh is very thin from side to side, and very deep antero-posteriorly. The bulk of muscle upon the back of the thigh preponderates over that upon the front almost as much as the calf-muscles do over those of the anterior region of the leg.

Sartorius.—(Fig. 32, *a*, and fig. 31, *d*.) A rather slim, flattened ribbon stretched between the apex of the ilium and the front of the knee, with no relation of contiguity in its course with any of the other muscles of the thigh. It arises by an aponeurosis from the top of the ilium, gradually narrows as it descends, and is inserted aponeurotic into the top and inner border of the "ligamentum patellæ." The peculiar office of the human tailor-muscle is not fulfilled in the least. The action is that of simple extension of the leg, and flexion of the thigh.

Rectus.—(Fig. 32, *b*, and fig. 31, *e*.) No femoral attachment to represent a cruræus. It lies in a bed formed by the vasti; blending with them is prevented by a fibrous investment along its whole under surface. It forms a stout, terete, fusiform belly, arising by a short, stout, flattened tendon from the border of the ilium just above the acetabulum.

Vasti.—(Fig. 32, *c*, externus; fig. 31, *f*, internus.) The two are inseparably blended for their whole length. The outer mass is much the larger, and also longer than the other; somewhat fusiform in general shape, but compressed; arising from the trochanter major, and outer half of the whole shaft of the bone, as far around as the insertions of the glutæus maximus and adductors, and quite to the condyle. The internus is rather pyriform in shape, arising from the rest of the shaft, from the neck to the inner condyle.

The conjoined tendon of the vasti and rectus does not embrace a distinct patella; a little speck of ossification, or several gritty particles, may, however, be found in old subjects. In this instance, at least, the tuberosity of the tibia is an olecranon. The tendon is about a quarter of an inch broad, occupying the groove between the condyles, and proceeding to the usual insertion. On either side it blends with the common capsular ligament, and aponeuroses of the two upper crural flexors. The homotypy of the rectus and vasti together with the triceps of the arm, is here even more strikingly displayed than in man. The rectus is the scapular head; the blended vasti are the similarly conjoined humeral heads. The sartorius as forcibly calls to mind the epitrochlear slip from the latissimus dorsi.

Gracilis.—(Fig. 32, *g*, and fig. 31, *o*, *o′*.) Largest of the crural flexors, and the most posterior as well as internal; a powerful flexor of the leg, and in less degree an adductor of the whole limb. It arises broad, thin and fleshy, from the whole of the symphysis pubis, between the articulation of the marsupial bone and the margin of the semimembranosus. It lies at first upon the adductors, and afterwards upon the crural flexors. At its origin it is an inch or more wide; it narrows very gradually to near the insertion, and is then suddenly reduced to a narrow, flat tendon, which passes across the inside of the leg, to be inserted into the crista tibiæ at the junction of the middle and upper thirds of the leg, just below the insertion of the semitendinosus.

Semimembranosus.—(Fig. 32, *f*, and fig. 31, *l*.) The origin of this muscle occupies the margin of the ischium between that of the preceding and following. But though it thus arises lowest down of any, it is inserted the highest up on the leg, crossing the semitendinosus in its course. It has nothing of the character indicated by its name, being a continuous fleshy belly of large size, prismatic, or almost semilunar in transverse section—the lower border of the adductor magnus lying in the longitudinal groove thus formed. Its short, narrow, and very thin tendon is inserted into the prominence on the inner side of the head of the tibia.

Semitendinosus.—(Fig. 32, *e*, and fig. 31, *m*.) Arises by a short, stout tendon in common with the biceps from the tuber ischii, forming a stout, flattened band that proceeds straight to the leg, to be inserted into the inside of the shaft of the tibia an inch below the joint—just above the insertion of the gracilis. The fleshy part suddenly contracts into a narrow, flat tendon, about an inch long. The muscle lies at first along the lower border of the biceps; and afterwards crosses the semimembranosus diagonally. Near the middle of its course there is a slight contraction, produced by a partial tendinous intersection; the cruro-coccygeus here effects the remarkable inosculation about to be described. In general characters this muscle most resembles the semimembranosus of anthropotomy.

Cruro-coccygeus.—(Fig. 32, *i*, *i'*, fig. 31, *n*.) This singular muscle arises from the transverse process of the third coccygeal vertebra, by a distinctly marked, short, narrow, flat tendon, and runs, as a flattened fleshy band of moderate size, directly transverse, past the tuberosity of the ischium, along the posterior border of the semitendinosus, with which it is in close apposition. It represents the posterior border of the thigh. At the constriction of the semitendinosus just mentioned, it dips into the substance of the latter, and the fleshy fibres of the two are completely blended. Separating again almost immediately after this inosculation, the muscle divides into two slips that diverge from each other, one proceeding to the inner, the other to the outer, side of the leg. The outer fasciculus, on reaching the leg, ends in a broad, thin aponeurosis, directly continuous with the aponeurotic tendon of the biceps, and is lost in the general fascia of the leg. The inner slip proceeds to be inserted near the tendon of the semitendinosus into the shaft of the tibia. Acting from the tail, this muscle is a flexor of the leg and extensor of the thigh; the occasion for its presence may be found in the necessity for an aid to, and increase of the power of the other muscles of the same set, to enable the animal the more readily to use its hind legs in regaining an ordinary position when suspended by the tail. Its two insertions appear to relate to those rotatory movements of the limb that begin at the knee and culminate at the ankle; when acting together they antagonize each other, and result in simple flexion.

Biceps.—(Fig. 32, *d*, *d*.) The fibular flexor of the leg has none of the characters that suggested its name in human anatomy. Its "short" or femoral head is wanting; it has no connection whatever with the femur. It arises from the tuber ischii by a short, stout tendon, common to the semitendinosus; it is separated from the femur by the quadratus femoris and adductor magnus; the continuation of the femoro-coccygeus separates it from the vastus externus. Beyond the insertion of the glutæus maximus, the biceps is in intimate relation, by its upper border, with the femoro-coccygeus; the aponeurotic insertion of the latter into the leg is a part of the expansive tendon of the biceps. Similarly, the lower border of the biceps is in relation with the cruro-coccygeus, after the latter has inosculated with the semitendinosus, and the aponeuroses are completely blended. The biceps becomes thinner and wider as it proceeds to the leg, almost covering all the other flexors in the lower part of its course; and finally expands into a very broad and thin aponeurosis, which, blended above and below with the similar fibrous expansions of the two coccygeals, covers the outside of the leg from the knee nearly half way to the ankle. This fibrous lamina has no direct insertion into the fibula; it may readily be lifted in its entirety from this bone, and traced around the leg as far as the crest of the tibia, which is its real final attachment. It becomes lost, in fact, in the common fascia of the leg, and ligaments of the knee joint. The diffuse indefinite insertion of the three flexing tendons on the outside of the leg is in striking contrast to the rigidly determined and exact insertion of the four that pass to the inner side. The want of two distinct heads of this crural flexor heightens its similarity to the corresponding muscle of the arm. The resemblance is increased in a curious manner by its virtual insertion into the tibia instead of the fibula, just as one part of the biceps of the arm is inserted into the ulna instead of the radius.

Pectineus.—(Fig. 31, *g*.) This is the smallest, shortest and uppermost of the adductorial set. It is a somewhat flattened fusiform muscle, arising by a very short, terete tendon from the outer border of the base of the marsupial bone, and inserted by a short, thin tendon, an inch broad, into the posterior aspect of the femur for a corresponding distance below the trochanter minor. It is a true adductor of the thigh; acting from the femur it draws the marsupial bone out from the belly and away from its fellow, antagonizing the pyramidalis. Sometimes it is double, *i. e.*, may be separated into two perfectly distinct parallel slips, with common origin, and directly continuous insertion. Its origin may be indicative of analogy, if not homology, between the marsupial bone and the " linea ilio-pectinea " of man.

Adductor parvus.—(Fig. 31, *h*.) The shortest of the three, but rather more bulky than the longus, which it separates from the magnus in one plane, and from the pectineus in another. It arises fleshy from the symphysis and border of the ramus of the pubis, separated from the extreme margin of the bone by the origin of the gracilis and the pubo-marsupial articulation, occupies the distance between the marsupial bone and the origin of the longus, and is overlaid in most of its extent by the pectineus and gracilis. Its short, thin, flat tendon, nearly an inch wide, is inserted into the femur between the pectineus and the longus. This muscle is the most decidedly adductorial of the three.

Adductor longus.—(Fig. 31, *i*.) A long, narrow, flat slip, lying in the same plane with the preceding, with the border of which it is in complete apposition. It arises from the symphysis pubis along the space between the origins of the preceding and following muscle, and is overlaid, in most of its extent, by the broad gracilis. It is inserted fleshy into the back part of the femur, from the insertion of the pectineus to within an inch of the inner condyle.

Adductor magnus.—(Fig. 31, *k*.) Much the largest of the three, forming a complete fleshy septum between the pubic and ischiatic sets of muscles. It is trapezoidal in outline; its lower border is much thickened. It arises from the whole of the lower border of the pelvis, from the tuberosity of the ischium to the symphysis pubis, along which extent its origin is overlaid successively by the biceps, semitendinosus, semimembranosus and gracilis. It is inserted fleshy into the whole length of the femur from a point opposite the trochanter minor, or just at the insertion of the quadratus, to the origin of the inner gastrocnemius. It is more of an extensor than adductor of the thigh. It may frequently be partially separated into two or three flattened bundles. In fact, the three adductors, having a continuous origin and insertion, and parallel contiguous course, appear in some instances to exchange fasciculi with each other. With exercise of the same care in dissecting in each instance, I have on several occasions worked out these muscles a little differently. The longus appears most variable, as it holds an intermediate position. The usual condition is as above described.

The noteworthy features of the muscles of the leg are numerous and interesting. The general disposition relates unequivocally to those rotatory movements that are equivalent to pronation and supination of the member, and to that grasping power of the extremity that transforms the latter to a true " hand." The muscles display the pedimanous character of the beast as clearly as does the nature of the articulation at the knee, ankle, or toe. There are two gastrocnemii, perfectly distinct from each other, with separate tendons and different insertions. The soleus is confined to the external gastrocnemius; it has no proper tendon. The plantaris is large; its tendon forms a third tendo achillis. There is no poplitæus. The long flexor of the toes lies upon the fibular, and the long flexor of the great toe upon the tibial, side of the leg. The peroneus longus has two insertions; the peroneus "tertius" is found as the proper extensor of the little toe. The "short" extensor of the toes, instead of lying upon the dorsum of the foot, comes down from the leg above, as one of the peroneal group, whose tendons pass behind the external malleolus; one fasciculus of it is left upon the instep, constituting the short extensor of the great toe. In like manner the "short" ("perforatus") flexor of the toes extends some distance up the leg upon the conjoined tendon of the long flexor, from which it takes origin. A curious arrangement of the flexing muscles of the great toe occurs.

Study of the muscles of the leg is facilitated by considering them in four groups: first, the anterior tibial—those that pass over the instep; second, the fibular—those that pass behind the external malleolus; third, the superficial posterior tibial—those that pass to the heel; fourth, the deep posterior tibial—those that pass behind the internal malleolus, or rather, over the heel, to the foot, including also the interosseus cruris.

Tibialis anticus (*"flexor tarsi tibialis"*).—(Fig. 33, *b.*) By far the largest muscle of this region; the fleshy part is of a somewhat prismatic shape, and extends along three-fourths of the leg. It arises from the head and upper third of the fibular side of the tibia, and intermuscular septum between itself and the common long digital extensor. Its stout, flattened tendon crosses the instep, just in front of the inner malleolus, bound down by the annular ligament, passes obliquely to the inner side of the foot, there to be inserted into the internal cuneiform bone (not base of first metatarsal). It has the usual action.

Extensor proprius pollicis longus. — (Fig. 33, *d.*) Deep-seated, and covered by the preceding and following muscle. A long, slender, fusiform belly, arising from the upper half of the tibial aspect of the fibula, somewhat blended with the short digital extensor, changing to a slender, flattened tendon just above the ankle, passing beneath the annular ligament, and thence proceeding very obliquely across the instep to gain the great toe, run along the latter, and be inserted into the base of the distal phalanx.

Extensor communis digitorum longus.—(Fig. 33, *c.*) A small muscle, overlying the preceding, arising from the head of the fibula in common with the peroneus brevis. Its muscular part is only two or three inches long; it rapidly divides into *four* parts, representing as many tendons These pass as one down the leg until they emerge from beneath the annular ligament, when they diverge to the four lesser toes, into the base of the ungual phalanges

Fig. 33.—Anterior tibial and fibular view of the left leg and foot; natural size. *a*, vastus externus.

of which they are inserted. The tendon of the middle toe often splits, to give off a slip to the second toe, which is thus doubly supplied.

Extensor communis digitorum brevis s. accessorius.—(Fig. 33, *k*, only the tendons shown.) As already intimated, this muscle, which in anthropotomy is found upon the dorsum of the foot, is here carried up the leg; only the pollical fasciculus being left upon the instep. It belongs to the fibular group. It is a diminutive muscle that arises from the upper part of the fibula for an inch or so below the head of the bone, more or less blended with the extensor longus pollicis, and covered by the peronei. In its whole course it lies close to the fibula, passes behind the external malleolus, and then immediately splits into *three* tendons, that pass to the second, third and fourth toes. These tendons are extremely attenuated, and run very obliquely across the instep, beneath the tendons of the preceding. Each runs along the fibular side of a toe, to be inserted into the base of the second (middle) phalanx. As the tendon that goes to the fourth toe passes the fifth metatarsal, it gives off a delicate slip to the little toe, which then has two extensor tendons besides its own from the peroneus tertius.

Extensor brevis pollicis.—(Fig. 33, *i*.) This detached remnant of the preceding, as it seems to be, though not lying upon the leg, may be most conveniently noticed in this connection. It is the only muscle upon the dorsum of the foot; it is devoted exclusively to the great toe, but occasionally gives off a little thread-like tendon to the second toe. It is a diminutive, fleshy fasciculus, lying diagonally across the instep from the external malleolus; its delicate tendon runs to the base of the distal phalanx of the great toe, alongside the tendon of the extensor longus pollicis.

Peroneus tertius, s. extensor minimi digiti.—(Fig. 33, *f*.) While the third peroneus of anthropotomy is sometimes wanting, and at best is little more than a part of the long common digital extensor, passing with the latter over the front of the ankle to reach the base of the fifth metatarsal, it is here found well developed, and in what appears to be its real character as a member of the fibular group, and the proper extensor of the little toe. Although small, it is a perfectly distinct muscle, arising from the head of the fibula, overlaid by the peroneus longus. The fleshy part is about an inch long, and forms a flattened spindle. The very long and exceedingly delicate tendon passes along the fibula, behind the external malleolus, along the external border of the foot, to be inserted into the base of the ungual phalanx of the little toe. It has also some attachment to the base of the little toe, but none to the fifth metatarsal.[1]

Peroneus secundus s. brevis.—(Fig. 33, *e*.) Very slender, fusiform, muscular for rather more than half its length, arising in common with the long digital extensor, distinct from,

[1]Anatomists differ as to the homology of the three muscles last described. If the fasciculus upon the dorsum of the foot be recognized as the whole of a rudimentary extensor digitorum communis brevis s. accessorius, the one above described under this name should rather be regarded as the peroneus tertius; and the extensor minimi digiti as a distinct muscle from the latter. Among other things that seem to favor this view (independently of the fact that actual dislocation of the parts of a morphologically simple muscle is rare, and therefore improbable in any given seeming instance), it may be stated that the extensor brevis of man only gives one tendon (that of the great toe) to be actually inserted into a digital phalanx, the other three blending with the corresponding tendons of the long extensor before insertion; and that, in the present example of the opossum, the fasciculus in question does really, at times, if not ordinarily, send another tendon to the second toe, thus allowing the inference that sometimes the third and fourth tendons may be developed. Should the muscle be found with these four tendons, its homology would be plainer. Moreover, even the third peroneal of man, despite its metatarsal insertion, appears to partake more of the character of a digital extensor, and may be therefore an undeveloped condition of the same muscle that is above described as the short or accessory

and anterior to, the long peroneal. It lies at first upon the preceding muscle and extensor of the great toe; afterwards upon the fibula, alongside the following muscle. Its flattened tendon passes behind the external malleolus, and thence straight to its insertion at the outside of the base of the fifth metatarsal.

Peroneus primus s. longus.—(Fig. 33, *g*, *g*.) The largest and most superficial of the peroneal group; a long, flattened spindle, muscular nearly to the ankle. It arises from the outermost part of the head of the fibula, and for a short distance from the shaft of the bone, and from the surrounding intermuscular septa. After passing behind the malleolus its short tendon dips obliquely forward, outward and downward, to gain the side of the foot; is there reflected around the cuboid, passes through a deep groove (converted by ligament into a sheath) in the under surface of the latter, runs obliquely across the sole, along the bases of the conjoined metatarsals, and is inserted into the outer side of the base of the first metatarsal. Opposite the base of the fifth metatarsal it gives off a short slip to be there inserted. It has the usual action, flexing and elevating the side of the tarsus, in the former respect coöperating with, in the latter counteracting, the tibialis anticus. The peroneus brevis and extensor longus pollicis assist, respectively, the peroneus longus and the tibialis anticus, in the lateral movements of the ankle joint. These four muscles, and the extensor of the digits, collectively oppose, by flexing the tarsus, all the remaining muscles of the leg.[1]

Gastrocnemius internus.—(Fig. 34, *c*.) This is entirely distinct from the external gastrocnemius and soleus, having separate insertion as well as origin, and no relation in its course except that of contiguity. It has extensive origin by a prismatic, fleshy head from the internal condyle, and greater part of popliteal space of femur, across to the outer condyle. About an inch and a half below the knee it suddenly contracts to a stout, flat tendon, which at the lower third of the leg crosses behind (outside) the tendon of the other gastrocnemius, to be inserted alongside the latter into the outer and lower corner of the tuberosity of the os calcis.

Gastrocnemius externus and *Soleus.*—(Fig. 34, *a* and *b*, and fig. 33, *h*.) The outer muscular belly of the calf is much larger than the other, and of complex structure, apparently resulting from blending with a soleus. Its three parts are disposed thus: A flattened ovate or split almond-shaped mass arises from the external condyle,

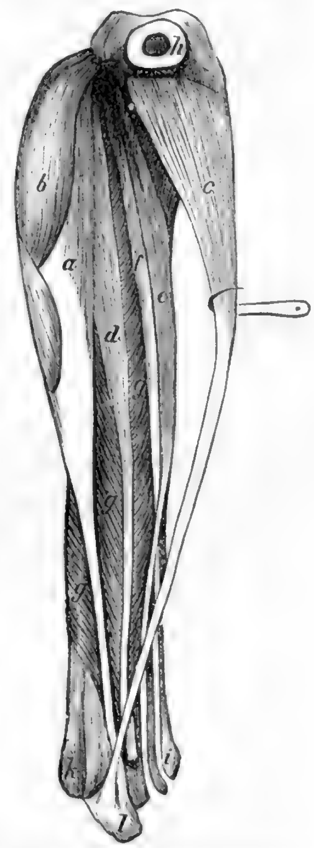


Fig. 34.—Left leg, posterior view; natural size.

digital extensor. Per contra, however, the human peroneus tertius may be an arrested extensor minimi digiti.

Again, the extensor of the opossum's little toe may be, morphologically, a part of the fibular muscle that supplies the next three toes; the two parts, then, together constituting the peroneus tertius. This second mode of viewing the subject leaves us free, as in the first instance, to identify the slip upon the dorsum of the foot as the whole of the flexor brevis digitorum, in a rudimentary condition.

With this explanation I allow the above descriptions to stand just as they were penned at the times of making the dissections.

[1] Prof. Owen thus describes the peroneal muscles of *Dasyurus macrurus* (op. cit., p. 16): "There are three peronei: the external one is inserted into the proximal end of the fifth metatarsal; the tendon of the middle peroneus crosses the sole in a groove of the cuboid, like the peroneus longus; the internal peroneus is an extensor of the outer or fifth toe." Of these, the first mentioned, or "external" peroneus, is the one described above as the *p. secundus* seu *brevis*; the next, or "middle" peroneus, is the *p. primus* seu *longus*, of this paper; while the last, or "internal" peroneus is the *p. tertius*—according to my identification.

at the termination of the vastus, lies upon the soleus, and blends with the latter far above where the same becomes tendinous; it is the superior and posterior, or superficial portion. Just below, and a little to the outer or fibular side, lies another smaller mass, taking origin exclusively from the surface of the soleus, with which it blends below. The soleus proper consists of two heads, the most posterior or superficial of which arises from the fibular sesamoid fabella and lateral knee joint ligament, and slightly from the external condyle; the most deep seated from the head of the fibula, between the peroneus longus and long digital flexor. The compound muscle, so constituted, forms a great protuberance, deep antero-posteriorly, narrow from side to side; tapering gradually as it descends, becoming tendinous a little below the middle of the leg, and then soon crossing inside (in front of) the tendon of the preceding, to be inserted into the inner lower corner of the tuberosity of the os calcis. Thus there are two perfectly distinct tendones achillis, without counting the plantaris as one. This muscle has no connection with the tibia. Is it likely that the politæus (no traces of which as a distinct muscle can be found) is represented by one of the divisions described?

Plantaris. Tensor fasciæ plantaris.—(Fig. 34, *d.*) Well developed, of large size, arising from the fibular fabella, distinct from the foregoing. It is a flattened muscle, becoming tendinous at the lower third of the leg. Its tendon passes along the inner border of the inner tendo achillis, lying upon the tendon of the flexor longus digitorum. It begins to become fascial above the heel, passes over the latter just inside of the os calcis, and is continued along the sole as the plantar fascia.

Flexor communis digitorum longus.—(Fig. 34, *g, g, g*, its muscular part, and fig. 35, *a*, its tendons.) This is the flexor perforans seu profundus, as proved no less by its own physical characters than by the relation that the short flexor of the toes bears to it. It lies upon the fibular side of the leg — exchanging places with its flexor longus pollicis, as far as anthropotomical relations are concerned. It is much the largest of the four muscles constituting the deep layer of the posterior set. It is bipinnatifid, and has a groove along its inner aspect in which the fibula lies partly embedded. It arises from the head and nearly all the shaft of the bone, blended somewhat above and on the inner side with the tibialis posticus. Just above the heel it becomes tendinous; a fibrous expansion of the tendon runs up the surface of the muscular part nearly to the head. The tendon—very short and much flattened—passes the heel in the deep notch between the os calcis and inner malleolus; and just at the middle of the sole disengages *four* tendons, that at once diverge to the four lesser toes. The conjoined tendon cannot be subdivided higher up; it is a single dense fibrous band. Each tendon lies upon the under surface of a toe, enclosed in a sort of sheath formed by lateral expansion of the tendon of the muscle next to be described, at length perforates the latter, and finally is inserted into the base of the distal phalanx. These tendons are quite stout, and flattened; each, in passing the continuity of the medial phalanx, is closely bound down by a distinct, strong, transverse, fibrous band. Before its division the large common tendon is joined by the tendons of the flexor longus pollicis, and the flexor brevis pollicis obliquus. The accessory muscles (lumbricales) are described further on.

Flexor digitorum "brevis." Flexor sublimis s. perforatus.—The homotypy of this muscle with the corresponding one of the hand, is not only proved by its relations to the long or profound flexor of the foot, but is further carried out, in a very interesting way, by the fact that, instead of being confined to the sole, as in anthropotomy, it arises above the heel, part way up the leg. The occasion for this prolongation of the muscle above the heel may be of a part with that which determined the similar extension of its antagonist, the extensor brevis digitorum, still higher up to the knee. (See, however, foot note on page 130). Instead of arising from the os calcis and being wholly a plantar muscle, as in man, this short flexor arises fleshy from, and lies upon, the common tendon of the long flexor, an inch or more above the heel. At the point in the sole where the long flexor tendon subdivides, this one also splits, likewise into four tendons, that pass one to each of the four lesser toes. The fasciculus going to the second toe is more or less distinct from the rest, and lies wholly or in part upon the tendon of the flexor longus pollicis. These tendons are all excessively delicate; those going to the second or third toes are the longest; fleshy fibres accompany the tendons to the base of the fourth and fifth toes. Each tendon at the base of a toe gives off on either side fascial expansions, that bind it to the common sheath of the toe, and embrace the heavy tendon of the deep or long flexor. Further on, each tendon splits, embracing again the deep tendon, and proceeds to be inserted into the base of the second phalanx. The lumbricales appear to belong almost as much to this set of tendons as to the deep ones.

Flexor longus pollicis.—(Fig. 34, *e*, and *b*.) A small flattened, fusiform muscle, arising from the head and outer aspect of the shaft of the tibia, and the intermuscular septum between itself and the tibialis posticus. Its long, slender, flattened tendon runs along the inner border of the tendon of the latter, passes in a groove behind the extremity of the tibia, gaining the sole of the foot, where it lies along the inner border of the flexor longus digitorum. It does not, however, proceed to the great toe, but is inserted into the tendons of the flexor longus digitorum and flexor brevis obliquus pollicis, just where the two latter become blended together. These three tendons thus fuse at a common point. Nature seems to have repented of making this animal's foot so much like a hand, and to have incontinently tied the two flexor tendons of the great toe to the common tendon of the other toes, so that this opposable digit cannot have other independent flexion than that afforded by the little muscles upon its ball.

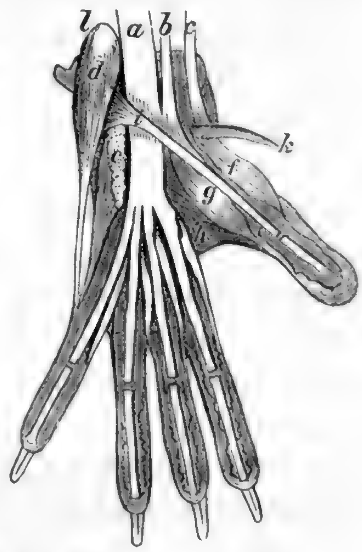


Fig. 35.—

Tibialis posticus (*extensor tarsi tibialis*).—(Fig. 34, *f*, and fig. 35, c.) A small muscle with a short belly, lying deep seated between the foregoing and the long digital flexor. It arises from the inner part of the head of the fibula, contiguous part of shaft of tibia, and intermuscular septum betwixt itself and the foregoing muscle. Its tendon, twice as long as the fleshy part, passes behind the internal malleolus, on the tibial side of the flexor longus digitorum, to be inserted into the inner side of the scaphoid.

Interosseus cruris. ("*Pronator fibulæ quadratus.*")[1] The interosseous space between the bones of the leg is occupied, from knee to ankle, by a plane of obliquely transverse fibres, situated between the two layers of the interosseous membrane. The direction of the fibres decussates with that of the aponeurotic fibres; and, particularly on the lower part of the front of the leg, the aponeurosis is very strong, dense and glistening. Though the muscle, as a matter of fact, cannot really pronate the limb, its action is in this direction;

[1] Prof. Owen (Comparative Anatomy and Physiology, iii, p. 15) says of this muscle, in the case of *Dasyurus macrurus*, that it "may be the homologue of the flexor digitorum communis;" and in the same animal he considers the muscle that sends flexor tendons to all the toes except the rudimental hallux, as the flexor longus pollicis.

it subserves the motion of the two bones upon each other, and may be the homotype of the pronator radii quadratus. The peculiar construction of the gastrocnemii and the relations of their tendons, has probably something to do in producing, or in aiding in the production of, the movements of the tibia and fibula upon each other.

The only muscle upon the dorsum of the foot has been already described. The plantar muscles are large and numerous, consisting of lumbricales, interossei, and the several special muscles of the great and little toes. The flexor brevis digitorum accessorius and transversus pedis, of anthropotomy, are wanting; the abductor pollicis is scarcely demonstrable as distinct from the flexor brevis pollicis. There is a calcaneo-metatarsal muscle not found in man. The chief flexor of the great toe has a curious disposition, of which I have seen no previous account.

Lumbricales.—(Fig. 35, seen attached to the tendon, *u.*) Four in number, all well developed. The first lies upon the tibial side of the tendon of the second toe; the others arise from the bifurcations between the other three tendons; all have intimate connection with the tendons of the superficial digital flexor. They form little terete bellies, each with a long, slender tendon, that runs along the inner side of a toe to the base of the second phalanx, where it is inserted.

Flexor brevis pollicis.—(Fig. 35, *f* and *g.*) This forms the chief ball of the great toe. It lies upon the first metatarsal, and consists of distinct halves, separated from each other by the stout tendon of the muscle next described. The two bundles lie parallel with each other, and are inserted respectively into the inner and outer sides of the base of the first phalanx. Each one embraces a sesamoid bone. The outer half has extensive origin from the inner surface of the closely appressed cartilaginous spur. This muscle might possibly be regarded as two, and the outer part be taken to represent an abductor s. opponens pollicis. But the action of the two halves is the same—simple flexion.

Flexor brevis pollicis obliquus.—(Fig. 35, *i.*) The great toe has another short flexor; a distinct and very curious muscle, that I shall have to describe under this name, not knowing what, if any, name it has already received. It arises by a short, stout, fleshy head from the whole of the depression on the outer (fibular) aspect of the os calcis. It curves around the lower border of this bone, between it and the short muscle of the little toe, and then suddenly contracts to a stout, flattened tendon, that traverses the sole diagonally (parallel with the course of the peroneus longus tendon). As it crosses the conjoined tendon of the flexor longus digitorum, it is firmly attached to the inner (tibial) side of the latter, just at the point where the flexor longus pollicis is similarly attached; it is, moreover, inseparably connected with the last named. Without losing its individuality by the blending of these tendons with it, it continues on to the first metatarsal, where it lies deeply embedded between the two parts of the muscle last described. Emerging, it finally passes to be inserted into the base of the last phalanx of the great toe, of which it is the chief and proper flexor. As it passes the first phalanx it is bound down by a distinct, stout, transverse band. While the flexor profundus digitorum of the hand has five tendons, one for each digit, the corresponding muscle of the foot has lost its pollical tendon, unless we can find it in this muscle. I am inclined to regard it as the displaced pollical fasciculus of the common long flexor of the toes. Notwithstanding its peculiar origin and diagonal course, it is inseparably connected with the tendon of the common digital flexor; and, moreover, the size and general appearance of its tendon, and particularly its mode of connection with the great toe, are precisely the same as those of a tendon of the digital flexor. In opposition to this view, however, it should be stated that the flexor longus pollicis of the hand is absent, or at least sends no tendon to the thumb, the fifth thumb tendon of the hand resulting from the confluence of this muscle with the common digital flexor; and that, as we have seen above, the flexor longus pollicis of the foot is present as a distinct muscle, only its tendon is arrested on its way to the great toe, and tied at the end to the tendon of the common flexor. Furthermore, in view of the connection of this oblique tendon with the tendon of the flexor longus pollicis, the muscle in question might be regarded as an accessory of the latter.

Adductor pollicis.—(Fig. 35, *h.*) A thin, fan-shaped plane of fibres, lying below the level of the interossei, stretching between the second and first metatarsals, converging to be inserted with the inner head of the flexor brevis, into the inner side of the base of the first phalanx of the great toe.

Flexor brevis minimi digiti.—(Fig. 35, *e*, cut off.) A thin, triangular plane of fibres of considerable superficial extent, its origin stretching across the foot from the cartilage upon the ball of the great toe to the base and part of the shaft of the fifth metatarsal, and also attached to the plantar fascia. Insertion at inner side of the base of the first phalanx of the fifth toe. This muscle may be found incompletely divisible into two parts, the inner of which would represent an adductor minimi digiti.

Abductor minimi digiti.—(Fig. 35, *d.*) A very distinct muscle, arising by a short, stout, fleshy belly from the under surface of the tuberosity of the os calcis, running along the external border of the foot, to be inserted into the outside of the base of the fifth toe.

Calcaneo-metatarsales.—These are two little flexing, or rather abducting, muscles of the fifth metatarsal itself, arising from the anterior part of the tuberosity of the os calcis, and passing to the outside of the base of the fifth metatarsal. They fill the deep notch between these two points, and floor the sheath through which the oblique flexor of the great toe passes.

Interossei.—The plantar interossei are of great size, forming a thick, soft cushion that fills the concavity of the sole formed by the curved metatarsals from the bases to the apices of these bones. That one upon the tibial side of the second toe is perfectly distinct from the others; the rest are much blended together. The tendons have the usual lateral insertions into the bases of the toes. They mostly embrace sesamoid bones.

PART III.—ON THE ANTERO-POSTERIOR SYMMETRY, OR LONGITUDINAL HOMOTYPY, OF THE MUSCLES OF THE LIMBS.

The foregoing account of the opossum's bones and muscles, as little more than a mere congeries of facts and observations, would appear fragmentary and pointless, were not at least the attempt made to deduce some of those generalizations that belong to the field of philosophic anatomy. In preceding pages certain morphological and teleological questions have been neither specially sought nor avoided, but treated, when they seemed naturally to arise in the course of the investigation, with whatever of light the writer's studies have afforded. Such, notably, have been the considerations touching the morphology of the skull regarded as a series of vertebræ; the correspondences of the bones of the fore and hind limbs; the general homologies of certain muscles, and, more especially, the teleological correlation of the muscular system with the movements and habits of the animal. It is desired, however, to offer in the present connection, as somewhat of a supplement to what has preceded, some thoughts upon questions of antero-posterior symmetry which have forced attention during the writer's dissections.

"If," as a distinguished anatomist has said, "antero-posterior symmetry can be shown to exist in the bones, then we can feel some confidence that whatever the difficulties at present may be with regard to the muscles, nerves and vessels, they will sooner or later be overcome." We believe that antero-posterior symmetry not only can be, but has been, demonstrated in the bones of the limbs of higher vertebrates, in the sense that, for instance, makes a humerus and a femur mutually correspondent: — the one a reversed representative of the other. Few, if any, anatomists to-day deny the main point, however widely they may differ in the details of their comparisons of fore and hind limbs as symmetrical repetitive parts of the skeleton. And if an arm and a leg are found correspondent as to their osseous structure, it seems to follow — we had almost said as a matter of course—that correspondence, similar in kind if not in degree, exists in the other tissues and organs, surrounding, nourishing, protecting and acting upon the bony framework. Assuming, then, without argument, the existence of special osteological homologies in limbs as a demonstrated fact, we infer similar existence of homology in the muscles, as a logical sequence. But the difficulty of directly proving such an inference to be true, is very great; so great, that the pointing out of muscle for muscle throughout the limbs has not yet been done, and perhaps never will be. *Pari passu* as we advance from the bare skeleton—the simple framework of the body—modifications of an ideal type increase in number and degree of complexity. Teleology may so far overshadow morphology that only glimpses, as it were, of original unity of plan can be discerned in the obscurity; or we may even be left in total darkness. But to the imperfection of our vision, perhaps, rather than to want of the whereupon to exercise it, may be ascribed our shortcoming in this respect; and if only one single ray of light be afforded us, it should encourage us to hope and seek for more. And I believe that we have at least one clear and steady beacon light to guide us in our search for the special homologies of the muscles of the limbs. This is found in the extensor muscle of the forearm and leg. The proposition, which appears almost axiomatic, may be thus stated: — If the humerus and the femur are in any sense correlated and correspondent, then the triceps extensor cubiti and the triceps extensor cruris are in the same sense correlated and correspondent.

Before any attempt is made to determine muscular homologies, a clear understanding of the homology of the several bones of the limbs is obviously necessary. Without repeating the arguments with which anatomists have for so many years defended their conflicting views with more or less success, it will be sufficient to present, in tabular form, the special homology of the bones that will be made the basis of the present inquiry into the corresponding relations of the muscles. Professor Wyman's method of viewing the skeleton is the one followed, except in the case of the coracoid and clavicle, as related to the ischium and pubis; in which instances Professor Owen's determination is adopted. The skeleton is suspended horizontally, the limbs depending vertically, each segment a little flexed, with the forearm supine, and the palm downward. In this position the scapular arch may be considered to point forward, and the pelvic backward; the arm points backward and the thigh forward; the forearm forward and the leg backward; the hand backward and the foot forward; the palm and sole both resting on the ground. Were another deflected segment allowed, the fingers would point forward and the toes backward; thus they are considered as reversing respectively the directions of the hand and foot. In this position, the axis of each segment points in an opposite direction, both to the homologous segment and its own succeeding segment, the salient angles at the flexures point in opposite directions, as the elbow backward, the knee forward; the front of the whole of one limb, as of its several segments, corresponds to the back of the other, and *vice versâ*: one is the reversed repetition of the other. The radius and fibula, and the thumb and little toe, are all upon the outside. We thus have, as homologous bones —

ANTERIOR EXTREMITY.	POSTERIOR EXTREMITY.	ANTERIOR EXTREMITY.	POSTERIOR EXTREMITY.
Scapula.	Ilium.	Pisiform.	———?
Coracoid.	Ischium.	Trapezium.	Cuboid.
Clavicle.	Pubis.	Trapezoid.	3d Cuneiform.
Humerus.	Femur.	Magnum.	2d Cuneiform.
Ulna.	Tibia.	Unciform.	1st Cuneiform.
Radius.	Fibula.	Metacarpals.	Metatarsals.
Scaphoid.	Astragalus.	Phalanges.	Phalanges.
Semilunar.	Os calcis.	Thumb.	Little toe.
Cuneiform.	Navicular.	Little finger.	Great toe.

It cannot of course be denied that there are muscles whose *general* homologies cannot be traced; muscles existing in one species or group of mammals, no indication of which can be found in other species or groups. But this fact does not detract from the pertinency of homologies of other muscles that do exist, and are traceable. The biceps, for example, of an opossum, is not the less the muscle so-called in a man or a monotreme, because an opossum may have muscles that the other two want, or conversely. Muscles are so far under the rule of teleology, that they may be, and are, frequently developed (according to what by-play, so to speak, of morphology we are ignorant) in the face of special emergency, as it were, to act definitely upon a particular organ or part, and are consequently not developed in those animals in which such particular organ or part is either wanting, or so far modified as not to require such muscular apparatus. Similarly — narrowing our range of observation, and turning from general to special homology, the expression of which we would seek in different parts of the same animal as evidence of the further operation of the law of antero-posterior symmetry that is found to hold with the bones—it cannot be denied that we find muscles in the fore and hind limbs that thus far have resisted every endeavor of ours to recognize their correlation; and the probability seems to be that there really are, on either of the pairs of limbs, muscles that have no existence, actual or "potential," in the other—whether as the result of extreme teleological modification, or of morphological difference, we do not presume to say. But such a fact should not be allowed to militate unduly against evidence in favor of a law of fore and hind symmetry; for non-existence of this, or any other law, is not to be assumed because its application to every detail cannot be shown. As far as I know, anatomists never have shown, and they probably never will show, the special homology of the highly differentiated and specialized muscles of the cranial and caudal extremities of the trunk; but this does not necessarily preclude the belief that these parts are reversed repetitions of each other. And it may fairly be assumed, I think, that there is an antero-posterior symmetry in the muscles of the limbs, if some muscles are demonstrably homologous in the same sense that the femur and humerus are, and many others afford nearly as unequivocal evidence to the same effect; in spite of the fact that some have not, as yet, been shown to be thus correlated.

I do not venture to hope that all — indeed, I scarcely think that most — of the special homologies I shall endeavor to point out will ultimately prove correct; my range of observation has been too limited for this. But even faltering and devious advance, in such a field as this, may be better than a stand-still; something will be gained if any points are firmly established; and even errors themselves may serve some useful purpose when they shall have been pointed out by better informed or more fortunate observers.

Bearing in mind the position and relations of the skeleton already assumed, it will be obvious that homologous muscles are to be sought for on opposite, which are homologous, sides of the limbs; that is, upon the front of the fore and back of the hind, or upon the back of the fore and front of the hind, extremities, in the longitudinal direction; and upon the same side, that is, upon the outer aspect of the arm and outer aspect of the leg, or upon the inner aspect of the arm and inner aspect of the leg, in the transverse direction. There is no known departure from this rule.

Position and relation are of first and last importance in the determination of muscular homologies, and, in fact, afford the only sure guides. For muscles are so variously and complexly modified, teleologically, for special purposes, that their function, or the end they subserve in the movements of a limb, is of all things the least likely to afford correct indications. Even origin and insertion are not infallible indices; for the same muscle varies in these respects within certain limits.

The terms "flexor" and "extensor," as ordinarily used, especially in anthropotomy, are incorrect in their application to certain muscles of the forearm and hand. Primarily, flexion is simply bending, and extension merely straightening, of the segment of a limb with reference to the preceding one; but in precise anatomical language these expressions have come to have an arbitrary and special signification. Still recollecting the assumed position of the limbs as above detailed, in which the axes of all the segments are more or less oblique to each other, "flexion" is the increasing of this obliquity by lessening the internal angles at the joints; and "extension" is the lessening of this obliquity by increasing the internal angles, till they equal 180°, and the several segments are straight with reference to each other's axes, when further extension at those joints where such motion is possible reinduces obliquity, but in the contrary direction to that in which "flexion" acted. Thus "flexor" muscles will invariably be found upon the back of the scapula, forearm and hand, and upon the front of the pelvis, leg and foot; upon the front of the arm and the back of the thigh; while conversely, "extensors" lie upon the front of the scapula, forearm and hand, and upon the back of the pelvis, leg and foot; upon the back of the arm and the front of the thigh. Applying this test, the so-called "flexors" upon the front of the forearm and palmar aspect of the wrist are in reality extensors, and the so-called "extensors" upon the back of the forearm and dorsum of the wrist are really flexors, and will be so designated in succeeding paragraphs, although in what has gone before the ordinary nomenclature has been observed. In reference to the leg and foot the usual interpretation of flexors and extensors is the correct one; the same is the case regarding digits. At the shoulder joint retroduction of the humerus is flexion, and conversely; on the contrary, at the hip joint retroduction of the femur is extension, and conversely. All other motions of joints are but combinations of flexion and extension; adduction and abduction are only transverse instead of longitudinal flexion and extension; circumduction comprehends both, the distal extremity of a segment describing a curved instead of a straight line; and even simple rotation, as at shoulder and hip, will be found, when closely examined, to be similarly reducible.

The direct action of many flexors and extensors upon a succeeding segment is complemented by an indirect action, whereby they become respectively extensors and flexors of a preceding segment—that one upon which they lie. Such flexors and extensors are those that take origin from a segment above that upon which they lie, and the second above that upon which they primarily and directly act. Thus the biceps, arising from the scapula, is a direct flexor of the forearm, and an indirect extensor of the arm, etc., etc. On the other hand, those that extend over but two instead of three segments, have no such complementary action; thus the brachialis anticus is purely a flexor of the forearm, and if it have any "reverse action," as when it contracts from its insertion as a fixed point, such operation still really tends to continued flexion of the forearm, by means of the flexion (retroduction) of the humerus that is induced. These, and many correlated facts, have been ably elucidated by Professor Wilder, in his paper "On Morphology and Teleology, especially in the Limbs of Mammalia," and been made the basis of a division of limb-muscles into systems of "long" and "short" flexors and extensors; which classification is made to play an important part in his determination of the special homologies, and beyond a doubt affords instructive indications in certain obscure cases.

The foregoing appear to be the principal theorems and definitions that will come into use in the present inquiry.

The scapular arch is loosely appended to the trunk, and enjoys free movement in various directions. With the exception of the loose sterno-clavicular articulation, its attachment is entirely by muscular tissue. The muscles are large, numerous, and varied in form, function and position; they are eight in number, viz.: the cleido-mastoid, subclavius, trapezius, rhomboideus, serratus with levator anguli scapulæ, "atlanto-acromialis," "atlanto-scapularis" (see page 112), and omo-hyoid. Of these eight, the first named may be morphologically a part of the sterno-mastoid, and the second appears referable, with obvious propriety, to the intercostal series. The omo-hyoid has been conjectured to belong to the same series, connecting as it does hæmal arches of contiguous cranial vertebræ—the occipital and parietal. The levator anguli scapulæ and serratus, believed by Professor Wilder in the case of the human subject to be one and the same dismembered muscle, are in the opossum actually one and the same; there is no division of their common plane, which extends unbroken from a long series of dorsal and cervical pleurapophysial elements, by numerous converging fascicles, to the occipital pleurapophysis. It is not, perhaps, going too far to suggest that these muscles may also be referable to the trunk series. Of the four muscles remaining after these eliminations, two connect the scapula with the diapophysis of the atlas alone, and two with the occiput and several spines of cervical and dorsal vertebræ. Thus it is seen that all the muscles of the scapular arch appear to grow out of the peculiar relations of this hæmal arch to its own and other vertebræ. While it would be premature and unwarrantable to assert that the scapular muscles are highly developed, differentiated and specialized components of the vertebral or trunk series, it cannot be denied that there are grounds upon which to base a belief that such may be the case. In this event, in spite of their important teleological relations to the fore limb, they would not form, morphologically speaking, an integral part of the muscles of that member.

Be this as it may, it is certain that there are no muscles in the hind extremity to correspond to these of the fore. Admitting some principle of antero-posterior symmetry, of however extended or restricted application, this very fact, so far from invalidating such an admission, rather confirms a belief in the theory. If the scapular arch were firmly bound in its proper morphological position, as it is in most of the class of fishes, and as the pelvic is in the present instance, it is a fair logical induction that these muscles would be greatly reduced in number if they were not to wholly disappear. In view of these considerations it would seem unreasonable to expect, conformably to any law of antero-posterior symmetry, that the scapular muscles should be repeated in the pelvis.

We may allude, in this connection, to a theory that supposes the morphological representation of the scapular muscles in the pelvico-vertebral ligaments. Independently of what has just been adduced, what is known regarding the transmutation of contractile muscular, and inelastic fibrous, tissues, is sufficient to hold this presumption in abeyance.

The pelvic arch, unlike the scapular, is immoveably attached to vertebræ, in what is not known to be other than its true morphological situation. Its mode of union with the spine may practically be considered the same as that by which most other hæmal arches—notably the costal—are joined. Of the several trunk muscles going to or from the pelvis, only one gives intimation that it is a muscle of the posterior extremity, properly speaking, and this intimation is by no means satisfactory. The caudal muscles arising on or in the pelvis are palpably part and parcel of the vertebral series. The abdominal muscles likewise are as evidently of the nature of the intercostal series, and only incidentally, as it were, attached to the pelvis. The exception just alluded to is the psoas parvus, which has definite insertion into the horizontal ramus of the pubis. This muscle I do not attempt to homologize; nor, so far as I know, has its homology been made out. Its scapular homologue is wanting; did it exist it would naturally be looked for in somewhat the position of the subclavius. It is questionably a proper muscle of the hind limb.

Proceeding now from the hæmal arches themselves to the proximal segment of their "diverging appendages," we straightway meet with farther difficulty. Six muscles, collectively known as the "rotatores femoris," are found about the hip, proceeding from the pelvis to the thigh, that have no scapulo-humeral homologues, so far as known. They are the quadratus, pyriformis, two obturatores, and two gemelli; the last two of which, however, are rather accessories of the obturator internus than distinct muscles, leaving really only four. Of these, one is what Wilder would probably call a "long" muscle, as it extends beyond the ilium to the vertebral column. These muscles appear to be developed, teleologically, to meet a special indication, which in the shoulder is fulfilled by the mode of insertion of muscles homologous with the pelvic glutæi. I do not venture to surmise what may be the true morphological import and relations of these rotatores, nor to suggest that they may be glutæal dismemberments, although some features of at least one of them, the quadratus, might be adduced in favor of such view. The obturatores scarcely afford me basis for conjecture.

The latissimus has thus far resisted all attempts that have been made to bring it satisfactorily into line. It is the "long" direct flexor of the humerus. The femur has no such muscle, unless it is found in the psoas magnus; and to this view of the case there are grave objections arising from the position and relations of the latter muscle. At the same time the psoas is not otherwise satisfactorily accounted for; at any rate, I cannot regard it as the "accessory short extensor" of the femur, nor see its homologue in the supraspinatus, as Professor Wilder has. Unless I misunderstand that writer's use of the terms, the psoas is the "direct long flexor" of the femur—just the opposite. For the rest, there is something to give color to the conjecture that the psoas and iliacus form one muscle, inasmuch as they have a common insertion, and similar function.

Few anatomists will be disposed to deny the homology of the subscapularis and iliacus; their position being identical, their relations nearly the same; and both having rotation as a prominent feature of their action. They both belong, furthermore, to the "short" flexor set, as "accessories."

There are three large muscles upon the outer surface of the scapular arch, all partly overlapping each other, all acting upon the proximal extremity of the humerus. They are, from before, backward,—deltoid, supraspinatus, infraspinatus. There are likewise three upon the outside of the pelvic arch, corresponding in position, relation, and virtually in function; they are, in reversed direction,—from behind, forward,—ecto-glutæus, meso-glutæus, ento-glutæus. These are readily acceptable as homologous; in fact, it is not easy to see how an opposite conclusion may be reached. In the case of the deltoid and ecto-glutæus, the correspondence extends to such an unusual degree as to be observable in the texture of the muscular fascicles. It is difficult to say to what set or sets of muscles—whether flexor or extensor, or long or short — these three muscles are morphologically reducible; the probability is, that they comprehend both. The glutæus maximus is certainly both long and short in having sacral and iliac portions; while the action of the three together, both at shoulder and hip, is so complex—and particularly in the cases of the spinati and two smaller glutæi—so varied in different animals, that they can hardly be said, in general terms, to have any specifically determinate mode of operation.

The teres major lies along the posterior border of the scapula, and is the short direct flexor of the humerus. At the hip there is a little muscle lying along the corresponding (anterior) border of the ilium, and morphologically the short direct flexor of the femur; although its diminutive size—in fact, its almost rudimentary condition—precludes belief that it is teleologically of much account. This is the muscle described (p. 125,) as ilio-femoralis; but which is undoubtedly the same as that described by Traill, Wilder and others in certain quadrumana, under the name of "scansorius." This seems to be the homologue of the teres major.

The teres minor is wanting in the opossum; were it present I should be at a loss to account for it. The glutæus minimus, to which Prof. Wilder compares it, has just been otherwise homologized. It is an inconstant muscle, and it may not be going too far to inquire whether it be really a morphological integer. The two rhomboidei, and the levator anguli scapulæ and serratus magnus of human anatomy are conclusively parts of each other, not integers of themselves; and similarly the teres minor may result from teleological modification of one of the two muscles between which it lies. If it be referable to the infra-spinatus, as seems likely, judging from its insertion, rather than to the teres major, the difficulty vanishes; for it is then correspondent to the glutæus minimus.

The way has grown smoother as we have advanced, until now, encountering the great extensor bundles upon the front of the femur and back of the humerus, it is perfectly clear. The triceps of the thigh is the triceps of the arm; it comprehends both long and short extensors of the next segment. The rectus femoris is the scapular head of the triceps, and is the long direct extensor. The vastus externus and vastus internus are respectively the outer and inner humeral heads of the triceps, and are the short direct extensors.

The peculiar office of the human sartorius is but faintly or not at all foreshadowed in lower mammals. In man a flexor of both thigh and leg, in other mammals, as in the opossum, it appears in its true character as accessory long extensor of the leg and indirect flexor of the thigh. Its homologue in the anterior extremity is the *de facto* slip from the latissimus but *de jure* distinct muscle, called by Owen omo-anconeus, and by Duvernoy dorso-épitrochlien.

In the anterior extremity a muscle, ordinarily of moderate size, in this instance extremely small, proceeds from the hæmapophysis to the shaft of the proximal segment of the diverging appendage; it is the coraco-brachialis. Similarly, in the hind limb, a set of muscles, ordinarily of great size, and in this instance extremely large, proceeds from the same to the same morphological point; they are the three adductors—magnus, longus and brevis; and there can be little doubt that collectively they are the homologue of the coraco-brachialis. The tests of position and relation go far toward proving this. It matters nothing that the one has little size or power, and that the other is large and strong. This is a purely teleological modification; and so is, also, the mutual relation of the two, considered as flexors or extensors; for the office of these muscles is notoriously variable in different animals. But it so happens in the opossum, from the shape of the parts, that the "adductors" are really powerful extensors, and only slightly adductive; and that what feeble action the coraco-brachialis has, is also extensive and adductive in about equal parts. The objection, that here are three muscles in the thigh to one in the arm, has little morphological import; but rather, on the contrary, is a good illustration of teleological dismemberment of a muscle—just such a modification as it is in some other cases expedient or necessary to take for granted.

One of the largest muscles or sets of muscles of the anterior extremity has not yet been accounted for — I allude to the pectoral. Their identification probably hinges upon our determination of the relationships of the clavicle and coracoid to the pubis and ischium. If the clavicle and pubis are the hæmal spines, and correspondent, the foregoing identification of the adductors with the coraco-brachialis is apparently most rational; both these muscles coming from hæmapophyses to the shaft of the first segment of the appendages; and there is nothing left to represent the pectorales but the pectineus. This is the view taken by Prof. Wilder. If, however, the clavicle be homologous with the ischium, as Prof. Wyman holds, the inference seems just, that the coraco-brachialis is repeated in the pectineus, and that consequently the pectorales are to be found in the adductors. I presume there is little or no question that the pectorales and coraco-brachialis are to be looked for, if at all, in the pectineus and adductors together; but a more special determination is rendered difficult by a variety of conditions. In the particular instance of the opossum, for example, the pectineus is really neither pubic nor ischiatic, but arises from the marsupial bone; and part of the origins of the adductors is pubic—that of the magnus alone being essentially ischiatic.

The cubital flexor system, situated upon the front of the arm, consists essentially of an outer, radial, "long" flexor, and an inner, ulnar, "short" flexor; one bending one of the two parallel bones of the second segment of the arm, the other the other; they are the "biceps" (flexor cubiti radialis) and the "brachialis anticus" (flexor cubiti ulnaris). Such appears to be the fundamental morphological condition of the cubital flexors, stripped of teleological modification; which latter, however, may be varied in degree if not in kind. In the opossum, for instance, the long flexor is bipedal instead of bicipital; its "long head" is deficient, or rather absorbed in the short or coracoid head, and one of its feet is implanted upon the ulna; but such conditions as these are of obviously little import in a morphological point of view. Now in the system of crural flexors upon the back of the thigh, the same general conditions are met with. There is an outer, fibular, "long" flexor, and an inner, tibial, set of flexors; the latter, however, subjected to a high degree of modification as compared with the corresponding flexor of the arm. Regarding the "biceps"—the flexor cruris fibularis—there is no difficulty; it is recognizable as the homologue of the muscle of the same name in the arm. Its femoral head, when existing, as in the case of man, etc., appears to be, so to speak, a teleological interpolation; in the opossum the muscle exists in what appears to be its normal condition; arising by a single head from the hæmapophysis to proceed to the outer side of the second segment, without attachment in its course to the first segment, of which it is still, as in other cases, the indirect short extensor. Some very suggestive corroborative evidence of its relationships to the cubital flexor has been already noticed at p. 127. The case is different with the internal or tibial flexors; their homology is not so evident. Aside from the fact that there are three such muscles instead of one (which of itself, however, would not constitute a valid objection to their reference to the brachialis anticus), they are not "short" but "long" flexors; they arise from the pelvic arch and not from the first segment of its appendage; and there is, moreover, in other animals, if not in the opossum, a muscle (the poplitæus) which is precisely the internal direct short flexor of the leg, arising from the femur and inserted into the tibia, and therefore in a teleological sense at least, the exact representative of the brachialis anticus, which Prof. Wilder considers it to be. But if the gracilis, semitendinosus and semi-membranosus arose together or individually from the femur instead of the pelvis, I presume that there would be no hesitation on the part of any in referring them collectively to the brachialis anticus; so that their origin may fairly be held as the only valid objection to such a view of their homology. The observed range of variation of origin of homologous muscles, however, does not seem to indicate that this is an extreme case, and other tests, as of position, relation, etc., tend to confirm the view that these muscles are really homologues of the brachialis anticus; more especially their unquestionable relations to the biceps cruris, the homology of which is so indisputable. If this view be not correct, it is certain that there is no muscle of the arm to which these important ones of the leg can be referred. I am of opinion, therefore, that the gracilis, semitendinosus and semimembranosus are the "short" direct tibial flexors, and consequently the homologues of the brachialis anticus, notwithstanding that the poplitæus appears to be such homologue.

The poplitæus, when present, could then only be regarded as an accessory flexor. Its reference to the pronator radii teres, to which it bears some superficial resemblance, could only be made upon the supposition of the homology of the radius with the tibia—a view which, it is scarcely necessary to repeat, I can not endorse. It is most probable that no homologue of the pronator teres can be found in the leg; and the same may be said of the supinator brevis. These two muscles, antagonistic in their action, appear as highly specialized developments, in the face of particular conditions necessary to the function of the hand, and so far as known, are not developed in the posterior extremity, although they would be looked for, if anywhere, in such a pedimanous animal as the opossum. The homologue of the pronator quadratus, however, is present in the interosseus muscle of the leg; one having substantially the same position, relation and function.

The supinator longus has been variously interpreted. Its insertion, in the human subject, into the styloid process of the radius, makes it virtually a humero-cubital muscle; and Prof. Wilder regards it as an accessory short flexor of the forearm like the other supinator and the pronator, and finds its homologue in the femoral head of the biceps cruris. With him, I look upon its supinating action as purely secondary, recognizing only flexion and extension as the fundamental motions of the limbs; but I conceive the muscle to belong to the carpal set, and see in it a long, direct, radial extensor of the wrist (what would be a "flexor" in ordinary anatomical language), and consequently as only an indirect "short" flexor of the forearm. For this, as well as for reasons already given, I cannot see the femoral head of the biceps in this homologue. In the opossum it goes to the wrist, not to the end of the radius. Bringing the supinator longus into this connection, it results that we have upon the radial side of the forearm four carpal muscles; two extensors—supinator longus and "flexor" carpi radialis; and two flexors—"extensor" carpi radialis longior and brevior; the homologues of which four are to be sought for in fibular, or outside muscles acting on the tarsus.

Noticing the origins and insertions of the long supinator and radial "flexor" (extensor), we find that the former arises from the outer, and the latter from the inner side or condyle of the humerus, and that both are inserted at or near the outside bone of the proximal carpal row—the scaphoid. In the leg there are two large extensor muscles, whereof one arises from the outer, and the other from the inner, condyle of the femur; and both proceed to be inserted by separate tendons into an outer bone of the proximal tarsal series—the calcaneum. These two extensor muscles, the gastrocnemii, in the opossum instructively distinct from each other in origin, course and insertion, have precisely the same relations in the leg that the supinator longus and "flexor" carpi radialis hold in the forearm. If our osteological premises are correct—and there seems no good reason for doubting this—the gastrocnemius externus is the homologue of the supinator longus, and the gastrocnemius internus is the homologue of the "flexor" (extensor) carpi radialis.

Looking now to the other two of the four radio-carpal muscles, we find that the "extensor" (flexor) carpi radialis longior and brevior arise together or contiguously from the outer condyle, lie along the radial side of the fore arm, and are inserted by distinct tendons into two contiguous parallel metacarpal bones—the second and third, counting from radial to ulnar side. Similarly, there are in the leg two fibular tarsal muscles, arising, if not from the outer femoral condyle itself, at least from the corresponding side of the leg, lying along the fibula, passing behind the external malleolus (= head of the radius) to gain the back and outer side of the tarsus, and finally proceed to a metatarsal insertion; they are the two larger peronei. The insertion of these muscles, however, does not, further than in being metatarsal, correspond to that of the wrist muscles just mentioned, for instead of going to contiguous second and third metatarsals, counting from without inward, one stops at the first (outer or "fifth" of ordinary anatomical language), and the other is carried quite across the foot to the fifth (inner or "first"). But this seems to be a result of special teleological modification, rather than a morphological disparity, and should not weigh unduly against numerous other evidences that the peroneus longus is the homologue of the "extensor" (flexor) carpi radialis longior, and the peroneus brevis the homologue of the "extensor" (flexor) carpi radialis brevior. Position, relation, and even function attest the correctness of this view. The peronei, like the so-called radial wrist "extensors," are really and essentially flexors; and in the ordinary position of the foot, at right angles with the leg, have actually this action, though when the foot is so strongly extended as to be brought in a straight line with the leg, they may act as extensors. This difference results solely from the mode of confinement of the tendons at the malleolus, and is purely teleological; a similar variance in the action of the radial wrist "extensors" would occur, were the tendons of the latter slipped around the head of the radius. The view here taken of these muscles is further supported upon a principle of exclusion, so to speak; the only other muscles to which the peronei could be referred being satisfactorily homologized without reference to the peronei.

The inner, or ulnar and tibial, muscles next come to be examined. There are two such muscles — a flexor and an extensor — in each limb. In the fore, the "extensor" (flexor) carpi ulnaris proceeds along the inner side and back of the forearm and wrist, to the base of the inner (fifth) metacarpal; it flexes the wrist, or draws it backward. In the hind, the tibialis anticus (flexor tarsi tibialis, as it has been well named), has entirely correspondent position and relations; passing over the inner side of the ankle and instep to the internal cuneiform bone, at the base of the inner (fifth — "first" of usual language) metatarsal, it flexes the foot, or draws it forward. Similarly, upon the other side of the fore limb, the "flexor" (extensor) carpi ulnaris proceeds along the inner side and front of the wrist, to the pisiform, extending the wrist or drawing it forward; and in the hind limb the tibialis posticus (extensor tarsi tibialis) has the same relations and functions, and virtually, if not actually, the same insertion, viz.: the navicular, which is the innermost of the proximal row, here taking the place of the pisiform, which has no tarsal homologue.

I find the "peroneus tertius" to be one of the most puzzling muscles of the limbs, and believe that others have met with similar difficulty in the attempt to determine its homology. In the first place, it is not easy to trace it from one animal to another, and so determine its general homology; for it is an inconstant muscle, wanting in many, if not the majority, of mammals, and when found it is variable in its position, relation and function. In man, for instance, the muscle called peroneus tertius is, when present, an insignificant one, looking like a detachment from the long digital extensor, and proceeding to the base of the outer metatarsal. In the opossum the muscle I call, and believe to be, peroneus tertius, is large and important, and the proper long extensor of the little toe; but I am not *fully* satisfied that this digital extensor is the peroneus tertius (see remarks, foot note, anteà, p. 130). Still this is the best identification I can make; any other involves greater objections. Thus, for example, if this little toe extensor of the opossum be not the third peroneus, it is an extra muscle, that has no correspondent in the hand, nor in many other mammals; the extensor minimi digiti of the fore limb being quite another thing. Again, upon the same supposition, we should be forced to view the muscle I call extensor digitorum brevis, as the peroneus tertius, in order to find the latter at all; a view against which, it need not be said, there are grave objections. These, and other considerations, lead me to see a peroneus tertius in this extensor of the little toe; and I base my search for its homologue in the fore limb upon this assumption. I cannot see the grounds of Prof. Wilder's reference of the peroneus tertius to the "extensor" (flexor) carpi radialis brevior, which seems to be naturally accounted for otherwise as I have just endeavored to show; and this view, moreover, necessitates his reference of the peroneus longus to the "flexor" (extensor) carpi radialis. There seem to be but two muscles upon the back of the hand to which the peroneus tertius can reasonably be referred; one is the extensor pollicis et indicis, the other the extensor metacarpi pollicis. For reasons given below, I identify the former of these with the extensor brevis digitorum pedis, and am consequently obliged to find the peroneus tertius in the extensor of the pollical metacarpal. It may be further urged, in support of this view, that these two muscles belong to corresponding groups, radial and fibular; occupy nearly similar positions upon corresponding sides of the hand and foot; and operate exclusively upon corresponding digits. Whatever objections may be brought against this view—and it is not denied that there are such—appear to be over balanced by evidence in its favor.

The plantaris is obviously homologous with the palmaris longus. A palmaris brevis is scarcely if at all demonstrable in the opossum; it probably has no homologue upon the sole of the foot.

Both fingers and toes are flexed by two sets of muscles, called in the arm "deep" and "superficial," and in the leg, "long" and "short." The short flexors of the toes, in the human subject confined to the sole, are in the opossum carried up the leg, and arise from, and lie upon, the conjoined tendon of the long flexor. The muscular parts of the superficial and deep flexors of the fingers are much blended. But however the origins and upper parts of these muscles may vary, in either arm or leg, or both, they preserve with remarkable constancy certain characteristics at their distal extremities and insertions. These are:—the tendons of the deep flexor of the fingers, and of the long flexor of the toes, are large and stout, are accompanied by accessory muscles (lumbricales) and proceed *through* the tendons of the other set to be inserted into ungual or distal phalanges; while the superficial flexor of the fingers, and the short flexor of the toes, are smaller and slender, unaccompanied by accessories, and proceed, by splitting, upon either side of the tendons of the other set, to be inserted into middle, or second phalanges. Such definite indications as these would seem to go so far toward establishing the homology of the deep with the long, and of the superficial with the short sets of flexors, that opposing evidence, to be valid, would have to be of the strongest kind.

While the correspondence of the deep digital flexor system of the hand with that of the foot is thus obvious and unquestionable, yet on carrying it out in details we meet with individual correlations as interesting as they are unexpected. For the four-tendoned long flexor of the toes is not, as would be thought at first glance, the homotype of the four-tendoned long flexor of the fingers, but of the single long flexor of the thumb, which in the opossum remains undeveloped; and similarly, the single long flexor of the great toe in the opossum, developed as to its muscular part, but abortive as to its tendinous part, is the homotype of the four-tendoned flexor of the fingers. This proposition is susceptible of pretty conclusive argument. In the arm the profound digital flexors consist essentially of a single muscle with five tendons, one for each digit; and when this is differentiated into two, the inner (ulnar) part of the muscle has four of the tendons for the four fingers, and the outer (radial) part has one tendon for the thumb. Likewise, in the leg, the originally five-tendoned flexor is differentiated into two muscles, an inner (tibial) muscle with one tendon for the great toe, and an outer (fibular) muscle with four tendons for the other toes. Now bearing in mind the relative positions of each of these special dismemberments, and remembering that our correspondences are to be drawn according to position and relation, not according to size, number of tendons, etc., it is necessary to conclude that the two *inner* (ulnar and tibial) moieties are homologous with each other, and that the two outer (radial and fibular) moieties are likewise mutually correlated. That is to say, the flexor longus proprius pollicis of the foot is the homotype of the flexor profundus digitorum of the hand; and the flexor longus digitorum of the foot is the homotype of the flexor longus proprius pollicis of the hand. In the opossum there is no actual long flexor of the thumb, unless, as is probably the case, the abortive fasciculus described as lying on the substance of the common deep flexor be that muscle; and similarly, the long flexor of the great toe, though distinct as to its muscular part, really sends no tendon to the toe; but this constitutes no valid objection whatever.

In further illustration of the homotypy of the long, deep, digital flexors, the reader is referred to my article (No. VIII) in the *Medical Record*, as above cited, where the curious special condition that occurs in man is especially treated of. These flexors are so notoriously inconstant in their amount of development, their number of tendons, and the particular digits that each serves, that confusion has arisen, which would be happily obviated by a little more precise nomenclature. Ignoring number of tendons, and the digits they serve, the following names are proposed: In the arm, flexor digitorum *ulnaris* for the inner moiety, and flexor digitorum *radialis* for the outer moiety; in the leg, flexor digitorum *tibialis* for the inner moiety, and flexor digitorum *fibularis* for the outer moiety. It is probable that similar considerations are applicable in special determinations of the superficial and short flexor systems, if not also the sets of digital extensors; but at present I am not prepared to follow up the subject.

Like the flexor, the extensor system consists essentially of two sets of muscles, which may be denominated the "long" and "short" in both limbs. The former is the more constant and important; it gives off, on the back of both hand and foot, four tendons, which supply the four fingers and the four lesser toes, the thumb and great toe wanting tendons, as in the instance of the flexor set. The same idea of a typical extensor muscle with five tendons—one to each digit—is more perfectly carried out than in the analogous case of the flexors. For here we have, not merely teleologically correspondent, but morphologically homologous muscles liberated on the same (inner) side of the hand and foot; they are the extensor proprius minimi digiti of the hand, and the extensor longus proprius pollicis of the foot. This identification of these two last named muscles is indisputable, and is not affected, apparently, by the question whether they really are dismemberments of the common extensor.

The extensors of the other set, the "short" or accessory, are more obscure, and their homologies more difficult to determine. In man the short extensor lies wholly upon the dorsum of the foot, and supplies the same digits that receive tendons from the long extensor; but in the opossum it is carried up the leg, and its tendons descend behind the external malleolus. In man, we have as the only muscles of the hand to correspond to this of the foot, the extensor indicis and extensors of the pollical internodes; in the opossum, one of the latter is deficient, and the other joins the extensor indicis, forming an extensor of the thumb and forefinger together. Whatever may be said upon the opposite, I have no alternative but to view these combined extensors as homologous with those of the foot just mentioned.

As will have been gathered from a former part of this memoir, the short palmar muscles of the thumb and little finger are very similar; and so also, are those of the great and little toe. They appear to consist essentially of a short flexor, an adductor, and an abductor in each instance; either of which, however, may be somewhat modified; as, for example, divided into two more or less distinct portions. The curious, oblique short flexor of the great toe, elsewhere particularly described, does not appear to belong to the group with which it is associated, but rather to be a specialized part of the long flexor system. With this exception, there appears to be little difficulty in homologizing the short palmar and plantar muscles. Bearing in mind the morphology of the digits, the short muscles of the little toe are to be referred to the thenar muscles of the hand, and those of the great toe to the hypothenar.

The lumbricales and interossei of hand and foot are obviously homologous. In the case of the former, identification of the individual tendons of the deep and long flexors determines them, each for each. Both sets of interossei are as easily determined, individually, by the correspondences of the digits with which they are in relation.

The following provisional table exhibits the homologies of the muscles of the fore and hind extremities, according to the identifications that I have endeavored to establish in the present study. However novel any of the correspondences may appear at first glance, it is hoped that they may not be hastily set aside, nor condemned without fair regard to the reasoning by which they have been reached. I should add that Part III. of the present memoir is merely an abridgement of an argument, originally penned some years since, and which in the interim has appeared in the New York *Medical Record*, as above cited, in its application to the muscles of the human subject; and that therefore it should be regarded as simply corroborative of the articles in the *Record*, and examined in connection with the latter. Some additional investigations of like character were made in a dissection of the Ornithorhynchus, and published in the last volume of the Proceedings of the Essex Institute.

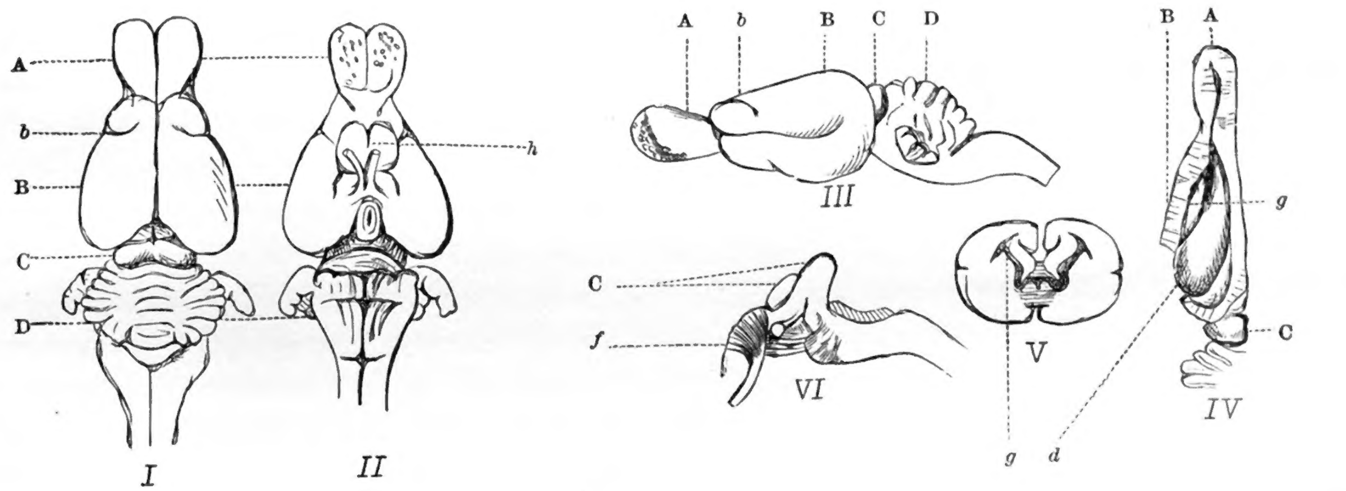
ANTERIOR EXTREMITY.	POSTERIOR EXTREMITY.
Cleido-mastoideus.	———
Subclavius.	———
Omo-hyoideus.	———
Trapezius.	———
Rhomboideus.	———
Atlanto-acromialis.	———
Atlanto-scapularis.	———
Levator anguli scapulæ.	———
Serratus magnus.	
(Qu.: muscles of the fore limb?)	
———	Psoas parvus.
———	Pyriformis.
———	Quadratus femoris.
———	Obturator externus.
———	Obturator internus.
———	Gemelli.
	(“Rotatores femoris.”)
Latissimus dorsi.	———?
———? (long, direct ? flexor.)	Psoas magnus. (long ? direct flexor.)
Subscapularis.	Iliacus.
Deltoideus.	Glutæus maximus.
Supraspinatus.	Glutæus medius.
Infraspinatus.	Glutæus minimus.
Teres major.	Ilio-femoralis.
Triceps (scapular head).	Triceps (rectus femoris).
Triceps (inner humeral head).	Triceps (vastus internus).
Triceps (outer humeral head).	Triceps (vastus externus).
Omo-anconeus (Dorso-epitrochlearis).	Sartorius.
Pectoralis.	Pectinæus.
Coraco-brachialis.	Adductores (three).
Biceps (Flexor cubiti radialis).	Biceps (Flexor cruris fibularis).
	Gracilis.
Brachialis anticus (Flexor cubiti ulnaris).	Semitendinosus. Flexores cruris tibiales.
	Semimembranosus.
———	Poplitæus (here wanting).
Pronator radii quadratus.	Interosseus cruris (Pronator fibulæ quadratus).
Pronator radii teres.	———?
Supinator brevis.	———?
Supinator longus (a radial wrist extensor).	Gastrocnemius externus.
Extensor[1] carpi radialis.	Gastrocnemius internus.
Flexor[2] carpi radialis longior.	Peroneus longus (Flexor tarsi fibularis longior).
Flexor[2] carpi radialis brevior.	Peroneus brevis (Flexor tarsi fibularis brevior).
Flexor[2] carpi ulnaris.	Tibialis anticus (Flexor tarsi tibialis).
Extensor[1] carpi ulnaris.	Tibialis posticus (Extensor tarsi tibialis).
Extensor ossis metacarpi pollicis.	Peroneus tertius.
Palmaris longus.	Plantaris.
Flexor digitorum profundus.	Flexor longus pollicis pedis (here abortive).
Flexor longus pollicis manûs (here rudimentary).	Flexor digitorum longus.
Flexor digitorum sublimis.	Flexor digitorum brevis.
Extensor digitorum communis.	Extensor digitorum longus.
Extensor indicis et pollicis.	Extensor digitorum brevis.
Extensor minimi digiti.	Extensor longus proprius pollicis.
Musculi breves pollicis (thenar).	Musculi breves minimi digiti.
Musculi breves minimi digiti (hypothenar).	Musculi breves pollicis pedis.
Lumbricales.	Lumbricales.
Interossei anconei.	Interossei rotulares.
Interossei palmares.	Interossei plantares.

[1] “Flexor” of ordinary language. [2] “Extensor” of ordinary language.

Description of the Brain of the Opossum. By Jeffries Wyman, M.D.

The most striking feature of the brain of the opossum, when compared with that of placental mammals, is the large size of the olfactory lobes, and their position in front of the cerebral hemispheres, the shortness of these last, the considerable interval between them and the cerebellum, and the consequent exposure of the optic lobes. When the skull is viewed as a whole, the cranial portion, which envelopes the brain, is remarkable for its diminutive size, and in this particular reminds one of the skull of a reptile.

Three specimens of adult brain which had been hardened in alcohol, and were therefore somewhat smaller than natural, displaced respectively 4.4, 4.4 and 4.5 cub. cent. of water, and one of them measured 40 mm. in length and 20 mm. in breadth.



I, upper, II, under, and III, side view of brain. IV, horizontal section, showing the ventricle of the olfactory lobe, corpus striatum, hippocampus, and the smaller convolution, also the optic lobes and a part of the cerebellum. V, transverse section behind the anterior commissure. VI, optic lobes, optic thalami and optic nerve.

A, Olfactory lobes. B, Cerebral lobes, or nates and testes. C, Optic lobes. D, Cerebellum. *b*, transverse furrow; *d*, large internal convolution, or hippocampus; *f*, optic thalamus and optic nerve; *g*, corpus striatum; *h*, bulging of the surface surrounded by well marked furrows.

Olfactory lobes.—Seen from above, these form two egg-shaped masses (figs. I, II, III, IV, A), flattened against each other, somewhat higher than broad, from 9 to 10 mm. long, from 5 to 6 mm. high, and merging without any very distinct line of separation in the lower half of the fore part of the cerebral lobes. Beneath they are from 12 to 13 mm. in length, underlap the cerebral lobes and here as well as on the sides are distinctly circumscribed. Each lobe is hollow, and if a cross vertical section is made each ventricle is seen as a nearly vertical slit inclined slightly outwards. It is largest in the middle of the lobe, contracts toward either end, but as it approaches the cerebral lobe connects with the ventricle of this, as seen in the horizontal section fig. IV, by an almost capillary opening.

The ventricle of the olfactory lobes nowhere communicates with the surface as, undoubtedly through the fault of the engraver, the figures of Owen seem to indicate.

Cerebral lobes.—The two together are somewhat pear shaped and considerably flattened vertically. (Figs. I, IV, B.) They separate from each other behind, leaving a triangular space in which the optic lobes are partly exposed. The surface is marked with very distinct vascular impressions which branch off from two principal trunks, the smaller one beginning near the optic chiasma and extending forwards and upwards, and the larger extending horizontally along nearly the whole length of the side of the lobe.

After the membranes are stripped off two infoldings or *convolutions* of the cortical substance are seen. The first (fig. III) corresponds in position with the larger vessel referred to above, and its sulcus is closed by this vessel superficially. Beginning just over the roots of the olfactory lobes it extends backwards in a curved line to the hinder part of the hemispheres. It divides each hemisphere on the surface into an upper and lower portion, the latter as already stated being continuous with the olfactory lobes. The second infolding is quite small and crosses the upper and fore part of each lobe (figs. I, III, *b*), forms a crescentic furrow, extends from near the middle line above, on to the sides and ends near the sulcus just described, but not connecting with it. On either side of the optic chiasma an oval bulging of the surface is seen (fig. II, *h*), having the appearance of a convolution and surrounded by a deep groove.

If a longitudinal section of the brain is made and the under part of the cerebral hemisphere lifted from its place, two additional infoldings of the surface are brought into view; the larger of them, beginning near the optic chiasma and winding around the inner surface of the hemisphere, is there seen on its vertical portion and ends near the union of the hemisphere with the olfactory lobe. The second infolding is quite small and is found just above the hinder part of the preceding. If the thin upper walls of the cerebral hemispheres are removed, two convex foldings, corresponding with the infoldings just described, will be seen, forming the oblique floor of the ventricle. The smaller and hindermost of these (fig. IV), though a distinct and constant part, does not appear to have been noticed in the descriptions of the brain of the opossum, but the larger (*d*) is known as the *hippocampus*. This last is of great size and fills nearly the whole cavity of the ventricle, and may be compared in shape to an ox horn, its point being directed forwards. Behind, it rests upon the nates and optic thalami, and in front it embraces the *corpus striatum* (*g*) in its hollow.

Commissures.—These are represented in the brain of the opossum, chiefly by the corpus callosum, fornix and anterior commissure. Owen, in his early and most valuable investigations of the brain of Marsupials and Monotremes, while he recognizes the existence of a "rudimental commencement of the corpus callosum," in his zoological conclusions and descriptions, leaves it out of the account as if it were wholly wanting, and assumes that the absence of it is an especial characteristic by which the Placental and Implacental Mammals are distinguished from each other, and this view has been largely accepted by zoologists. Leuret, Blainville, Pappenheim and other continental anatomists have expressed their dissent to this view, and Mr. Flower, by a series of comparative dissections, has shown the actual presence but gradual reduction of the corpus callosum in Placental Mammals, and its still further reduction in Marsupials and Monotremes. Throughout the whole of both series, this part retains its essential features and is simply reduced in size by being shortened from behind forwards so that its hinder edge, instead of being over the tubercula quadrigemina as in man, is just above the anterior commissure. Owen, however, maintains that the corpus callosum in Implacentals has a morphological value only and not a zoological, and is no more the corpus callosum of Placentals than a "bract" is a "leaf." By a parity of reasoning a Batrachian might be described as destitute of a cerebellum.

When the hemispheres of the opossum are separated from each other, the corpus callosum is brought into view at the fore part of the longitudinal fissure, just above and resting upon the fore part of the optic thalami, consisting of a transverse, nearly cylindrical band, somewhat compressed from above downwards, and attached to the inner walls of the two adjoining hemispheres. It consists of white fibres which enter the substance of the hemisphere just below the hippocampal sulcus, where the fibres radiate in a fan-shaped manner, but chiefly backwards, and are spread out over the convex surface of the hippocampus and end in the cerebral walls along the angle where these are reflected upwards in the great longitudinal fissure. The remainder of the fibres are directed forwards and downwards and were traced to the fore part of the cerebral lobe. It will be seen, therefore, that the connections established by means of the corpus callosum are quite extensive.

It is in the reduction of the corpus callosum to its diminutive proportions that the brain of the Marsupials and Monotremes most closely resembles that of the oviparous classes, in which last no trace of it has thus far been recognized. In all other respects, however, it maintains its mammalian features, and shows nothing deviating from these to the same extent as do the organs of generation, from the usual structure of these parts in ordinary or placental mammals.

The parts which are supposed to represent the *fornix* in the opossum, though quite diminutive, are traced without much difficulty. They consist of two fibrous bands slightly separated from each other, which at one end are connected with the foremost part of the optic thalami, thence pass upwards over the "hard" or anterior commissure, resting closely on its surface and at the same place becoming attached to and apparently interchanging fibres with it, and descending in front of it are lost in the cerebral substance adjoining. Some of the fibres make a nearly complete circuit of the commissure. The portions of the fornix which lie in front of, and behind, the anterior commissure, correspond with the so called "pillars"; and if we could suppose the corpus callosum gradually enlarged and its hinder edge pushed backwards carrying the attachment of the fornix with it, these pillars would be gradually lengthened so as assume the proportions they have in Placental Mammals, those in front being the ones which Huxley calls precommissural.

In the median longitudinal section, the divided *great commissure* and the corpus callosum are represented by two oval sections, the long axes of which incline towards each other from opposite directions, and if prolonged would meet in front of them. The section of the *great commissure* is nearly twice as large as the other, and has only the pillars of the fornix interposed between it and the optic thalamus. Its fibres are easily traced, radiating into the adjoining parts until they are lost in the fore part of the cerebral lobes and the corpora striata.

The *Optic lobes* (tubercula quadrigemina) taken together, form a wedge-shaped mass inserted between the cerebellum and the optic thalami, and in general resemble the same parts in the rat. The *testes* issue vertically from the fourth ventricle, and have on their hinder face a deep concavity which the middle lobe of the cerebellum fills. Above they are divided into two oval masses, become much thicker below, and as they approach the crura, the lowest part projecting forwards. The *nates* are much smaller, are also divided into two lobes, have a flattened oval shape, and rest upon the more advanced portion of the testes to which they seem only appendages.

The optic thalami, nates and testes might be described superficially as a single mass of cerebral substance divided by grooves into three pairs of lobes, the groove between the nates becoming suddenly deeper at its foremost point so that its continuation separates the optic thalami from each other, and thus forms the third ventricle. On each side of the entrance to the third ventricle is a raised lip on which the peduncles of the pineal body rest. The connections of the thalami with the fornix have already been described.

The passage from the third to the fourth ventricle becomes suddenly enlarged, under the optic lobes, and if a transverse section be made through these it assumes the dimensions of a ventricle under the testes.

The optic tracts reaching the sides of the optic thalami, spread out in a fan-shaped manner covering the whole surface. A few fibres were traced into the nates and into a small, flattened, circular body, which occupies the place of a corpus geniculatum.

The *Cerebellum* consists of a middle lobe which, seen from behind, has nine convolutions, some of which do not extend beyond its borders; of two lateral lobes, each with six or seven convolutions, the upper and lower of which extend across the median line; and of the slender appendages on each lateral lobe usually seen in Marsupials, each of which has three or four minute convolutions. The middle lobe forms a continuous ridge around nearly the whole circumference of the cerebellum, being interrupted only on its hinder edge over the fourth ventricle. Besides the sulci seen on the general surface, there are two somewhat remarkable ones, which can only be seen by examining the anterior or that face of the organ which is in contact with the vertical portion of the testes. One of these detaches the middle lobe in front, as far as the base of the cerebellum, from the posterior, middle and lateral lobes; the entrance to it is from near the top of the cerebellum, and its direction, as seen in a longitudinal section, is from above downwards and backwards. A second and smaller one is seen below this and has a direction parallel to it.