is to be detected in the constituent parts of the cartilaginous cranium. Nevertheless it is undeniable that there is a singular secondary and induced resemblance to vertebræ in these ossified skeletal parts.

The osseous condition of the third category of cranial skeletal parts varies extremely in different classes of Vertebrates. The limits of this article are altogether insufficient for more than a brief indication of the main varieties of the cranial structures of any of the three categories, and the reader must refer for details to the descriptions given in the various articles of this work which are devoted to different groups of animals.

The most anterior lateral descending bar or visceral arc is known as the mandibular arch. That part of it which extends forwards and forms the upper jaw presents us with the following ossifications arranged in two rows—one external, the other internal. The external row, proceeding from before backwards, consists of premaxilla, maxilla, jugal (or malar), and very often of a quadratojugal, which latter, when present, is generally in the form of a bar of bone (with an interval between it and the skull), forming, or helping to form, an inferior lateral external arch analogous to the superior lateral arch already noticed as the "zygoma." There may be a pair of premaxillæ, or they may be represented by an azygous bone. The premaxilla, maxilla, and jugal often unite with the anterior outer margins of the nasal, frontal, and lachrymal to form a continuous bony external wall to the anterior part of the skull. The internal row of bones, proceeding again from before backwards, consists of the vomer, palatine, and pterygoid, which, with their fellows of the opposite side (and sometimes with the aid of the parasphenoid), form the bony roof to the mouth, which roof may (as in Mammals and Crocodiles) be a continuous bony partition, or may be but a sort of open bony framework. Besides the pterygoid proper, other ossifications, adjoining it, have been distinguished as the entopterygoid and ectopterygoid.

The lower part of the most anterior lateral visceral arc forms all or part of the lower jaw. In the *Mammalia* it forms the whole of that jaw, and is invested by but a single bone—the dentary. In other Vertebrates it forms but the distal, though greater, part of that jaw, and may be invested, not only by a dentary, but also by bones called angular, subangular, coronoid, and splenial. The jaw is further continued, proximally, by two bones—the articular and the quadrate—which are ossifications of the cartilaginous arc itself. This may, as in Birds and Reptiles, be directly articulated to the cranial wall, or it may be (as in Fishes) suspended therefrom by bones, the highest of which is termed the hyomandibular, which articulates with the ossified auditory capsule. The hyomandibular joins below two other bones, the anterior of which is called the metapterygoid and the posterior the symplectic, to both of which the quadrate is attached. Thus these four bones act as a "suspensorium" for the lower jaw, the joint between which jaw and the suspensorium is placed at the junction of the quadrate and the articular. In Mammals, parts answering to the suspensorium, the quadrate, and the articular form no part of the jaw but are of relatively minute size and are known as certain parts (the auditory ossicles, &c.) of the internal ear,[1] and are protected externally by an ossification called the tympanic bone.

The second lateral descending bar or visceral arc, known as the hyoidean arch, may have its upper part ossified, in union with the preceding arch, as in the bony suspensorium of Fishes just described. On the other hand its upper part may, as in Mammals, be represented only by minute parts of the internal ear,—except the very summit of the arch, which forms the tympanohyal, and is anchylosed to the ossified auditory capsule of the internal ear. In Bony Fishes the hyoidean arch begins to free itself from the suspensorium, as a bone called the stylohyal, which is attached to the preceding or mandibular arch, between the hyomandibular and the symplectic. The arc then continues downwards as the epihyal and ceratohyal, ending below in the basihyal, from which a glossohyal may project forwards and a urohyal backwards. In Fishes certain styliform ossicles termed branchiostegal rays may project backwards from the hyoidean arch; and above them certain membrane bones called opercular bones—the operculum, preoperculum, suboperculum, and interoperculum—are attached above to the hyomandibular, and lie outside the mandibular and hyoidean arches.

In the air-breathing Vertebrates the hyoidean arch may be well developed or very imperfectly so, and concurs with parts belonging to the more posteriorly situated lateral arches to form a complex bone—the os hyoides—as will be further described.

These more posterior lateral arches—the branchial arches—attain their most complex osseous condition in Bony Fishes, which have commonly five of them, not solidly united to the skull above, but connected one with another inferiorly and with the inferior part of the hyoid arch. From below upwards these arches consist generally of a basibranchial, a hypobranchial, a ceratobranchial, an epibranchial, and a pharyngobranchial, but the hindmost arch is less fully and complexly formed.

In air-breathing Vertebrates the already-mentioned os hyoides consists of a central part or "body," to which are attached two pairs of single or jointed processes termed cornua. The anterior pair of cornua (known in human anatomy as the lesser cornua) represent the hyoidean arch, and may contain all its bones, including the "tympanohyal." The posterior pair of cornua (the greater cornua of human anatomy and the thyrohyals of Mammals generally) answer to or represent part of the branchial arches, and may be longer or shorter than the anterior pair of cornua. That they really have this homology is proved by the process of metamorphosis of the Tadpole, which in its early stage has distinct cartilaginous branchial arches that become the posterior cornua of the os hyoides of the adult Frog.

The osseous skull may, its bones remaining distinct, form a very solid whole, and the brain-case may be complete, as in Mammals, or it may be very loosely constructed and largely membranous, as, *e.g.*, in most Lizards. Teeth may be connected with various bones,—most constantly with the dentary, maxillæ, and premaxillæ,—but the palatines, pterygoids, parasphenoid (in *Plethodon*), pharyngobranchials, and even the basiocciptal (Carp and Tench), may be dentigerous.

The structure of the skull is so exceedingly complex and varied that it is impossible within the limits of the present article to do more than give the above general indications. For further particulars the reader is referred to the anatomical details which will be found in the several articles of this work which are devoted to the description of different single groups of Vertebrate animals, and especially to the description of the skull of Man in the article ANATOMY.

[1] The exact and precise homologies of these parts seem still to be *sub judice*.

APPENDICULAR SKELETON.

This part of the internal skeleton of Vertebrate animals normally supports two pairs of limbs only, but in one class—that of Fishes—there are azygous structures—the unpaired fins—which, as before said, must be reckoned as belonging to this category. These latter will be more conveniently treated of later. The whole appendicular skeleton may, however, be wanting, as in the Lamprey and in most Serpents.

The Skeleton of the Paired Limbs.—The paired-limb skeleton normally consists of that of an anterior, pectoral, or thoracic pair of limbs and that of a posterior or pelvic pair. In certain species there may be but a single pair of limbs, which may either be the pectoral pair, as, *e.g.*, in the Amphibian genus *Siren*, or the pelvic pair, as in the Reptilian genera *Bipes*, *Lialis*, and *Ophiodes*.

Normally each pair consists of diverging appendages—the limb skeleton proper—attached to a solid structure embracing parts of the trunk, *i.e.*, a limb-root or limb-girdle. A thoracic limb-girdle may exist in a well-developed condition without any limbs attached to it—as in the Slow-Worm (*Anguis*), but there is never a well-developed pelvic girdle without a rudiment of a pelvic limb.

In all Vertebrates above Fishes the limbs are divisible into a main part of the limb—arm or leg,—with a distal part or extremity—"manus" (hand) or "pes" (foot). We sometimes find (as in *Lialis*, *Python*, and *Balæna*) a rudimentary development of the skeleton of the leg without any rudiment of a pes; but we never find any rudimentary development of an arm without any rudiments of a manus. In the paired limb, as we have seen, a limb-girdle may be present without any part of a limb, but no part of the limb skeleton is ever developed without any limb-girdle. Normally the two limb-girdles are attached in a solid manner to the axial skeleton, in different modes.

Normally the pectoral girdle is only thus connected with the axial skeleton by its ventral part, or with the ventral part of that skeleton, *i.e.*, with the sternum, while it ends freely above, being dorsally connected with the axial skeleton only by soft structures. In Fishes, however, it may abut by its dorsal extremities on each side against the neural region of the spinal column, as in *Raia clavata*, or be connected with the head by skeletal structures, as in Bony Fishes, *e.g.*, Perch, Cod, &c.,—having all the time no connexion with the spine by its ventral part.

The pelvic girdle, on the contrary, is normally connected by its dorsal part solidly with the axial skeleton, though, as in Fishes, it may not be at all so connected. It never, however, abuts ventrally against the axial skeleton as does the thoracic girdle.

Appendicular Skeleton of Vertebrates above Fishes.

The paired limbs of all animals above Fishes are formed on one type, and differ greatly from those of the last-mentioned class. It will be convenient to describe first the general condition of the limbs in Mammals, Birds, Reptiles, and Amphibians.

Both the thoracic and pelvic limbs of these animals are divided, as before said, into main parts (arm and leg) and extremity (manus and pes). Each main part is further subdivided into a proximal segment (upper arm and thigh) and a distal segment (fore-arm and lower part of the leg). Each extremity is subdivided into a root portion ("carpus" and "tarsus"), a middle portion ("metacarpus" and "metatarsus"), and a terminal portion known as the digits. Thus the skeleton, *e.g.*, of the hand of Man is composed of—(1) the root part of the hand or the "carpus" (made up of eight small bones); (2) the middle part of the hand or "metacarpus" (made up of five long bones enclosed in the flesh of the palm); and (3) that of the digits, *i.e.*, of the thumb (or "pollex") and of the four fingers, while the great toe (or "hallux") and the four other toes are the "digits" of the pes.

The joints between the proximal and distal segments of the main part of each limb are the elbow and the knee, and these are turned mostly (as in ourselves) in opposite directions. Primitively, however, in all animals and permanently in some (*e.g.*, Tortoises), both these joints are so conditioned as to open inwards—the elbow and knee being both directed outwards—while the palm of the manus and the sole of the pes are also both inwards in the embryo, and in the adult are applied to the ground, the digits of each extremity being directed outwards. This is the position in which the correspondence in structure between the thoracic and pelvic limbs is most obvious, and in it the whole surface of the limbs, which (on account of the muscles there placed) is known as the "extensor" surface, is turned outwards, whereas that known as the "flexor" surface is turned inwards, while the pollex of the manus and the hallux of the pes are both in front of their respective extremities. This primitive condition is altered during the process of development of Man and most air-breathing Vertebrates, the knee becoming bent forwards and the elbow backwards, while the fore-arm is twisted by a movement called "pronation," so as to enable the flexor or palmar surface of the manus to be applied in a direction parallel to that of the flexor or plantar surface of the pes.

In Bats the thigh is turned backwards, so that the knee bends backwards like an elbow. Were it necessary in these animals to apply the sole of the pes to the ground with the digits forwards (as in most animals), then a pronation of the lower leg would be needed in them, similar to the pronation of the fore-arm, which, as above said, takes place in the majority of animals here referred to—air-breathing Vertebrates.

The Thoracic or Pectoral Limb-Girdle.—The shoulder-girdle normally consists of the following bones or cartilages:—(1) a superior portion, generally a more or less broad plate of bone, called the scapula, the upper part of which may remain cartilaginous and more or less distinguishable as a suprascapula; (2) a posterior inferior portion, named the coracoid, which may or may not be continuous with the scapula, and may have additional parts or subdivisions distinguished as the coracoid proper, precoracoid, and epicoracoid; at the junction of the scapula and coracoid there is a concave articular surface—the glenoid cavity, into which the pectoral limb is articulated; (3) an anterior inferior portion, called the clavicle, which may abut against an azygous median structure known as an interclavicle, the two being distinguished from the other elements of the girdle by being more or less entirely membrane bones.

These structures are found well developed in many Lizards and quite exceptionally in Monotremes amongst Mammals. In them and in Birds, the coracoids are largely developed, while they remain mere processes of the scapula in non-Monotrematous Mammals, and sometimes are quite rudimentary. In such Mammals the pectoral arch is only completed inferiorly by the clavicles which abut against the sternum, but sometimes (as, *e.g.*, in Ungulates) are altogether absent. The "merrythought" of Birds is a clavicular structure. In Amphibians the two halves of the shoulder-girdle are, each formed of a continuous plate. Some anatomists reckon part of this as representing a clavicle, but this determination is very doubtful.

The Pelvic Girdle.—This girdle, like the former one, normally consists of three parts—one dorsal, the ilium, and two ventral, whereof the more anterior is the pubis and the posterior the ischium, and all these are cartilage bones. The pubis generally meets ventrally its fellow of the opposite side, but not always so. The ischia meet ventrally more rarely. In Birds and certain extinct Reptiles a third element, the post-pubis, intervenes between the ischium (more or less parallel to the latter) and a pubis which may be fully or only rudimentarily developed. At the junction of the ilium and the ventral pelvic elements the is a concave articular surface for the pelvic limb, the acetabulum. An interval between the pubis and ischium of each side is known as the obturator foramen. We find amongst Amphibians there is a peculiar cartilage in the ventral median line in front of the pubis, which has been called the prepubic cartilage.[1] In Marsupials and Monotremes a bone extends forwards in front of each pubis, and these bones are known as the marsupial bones.

The Limbs.—The general condition of these organs and the bones supporting them in Vertebrates above Fishes having already been indicated, it remains but to fill in a few details as to their normal structure and its principal varieties.

A. Pectoral.—The bone of the upper arm is called the *humerus*, and is more or less cylindrical in shape, with an expansion at each end. It may, however, be almost as broad as long, as in the Mole and some Cetacea. The lower arm is generally furnished with two bones, the radius and the ulna, placed side by side. The ulna may be more or less abortive, as in Ruminants and Bats, but it may be the larger of the two fore-arm bones, as is the case amongst Birds.

The *carpus* may have its parts more or less permanently cartilaginous, as in some Urodeles and Cetaceans.

Taking the carpus of Man as a type of the ossified carpus (for further details, see ANATOMY), it consists of the eight following short bones arranged in two transverse rows. The proximal row (that next the arm) includes the scaphoides, lunare, cuneiforme, and pisiforme, while the distal row (that next the fingers) comprises the trapezium, trapezoides, magnum, and unciforme—starting, in each enumeration, from the thumb side of the manus. The pisiforme stands out from the rest, and is reckoned as a sesamoid bone

[1] Balfour, *loc. cit.*, p. 499.

or ossification of a tendon, rather than a true carpal ossicle. There may be an analogous sesamoid ossicle on the other side of the wrist (on the side of the scaphoid) even in Apes, and this obtains its maximum in the Mole, where it strengthens and broadens the manus for digging. The true carpal bones may be more numerous or less numerous than in Man. Thus there may be an ossicle—called intermedium or centrale—placed in the mid line between the two rows of carpals, and this may be double, as in *Cryptobranchus* and some Siberian Urodeles. The uniciforme may also be represented by two bones, as amongst Chelonians; the pisiforme is often absent, and also the trapezium. The bones of the distal row are the less constant in number and development, and they may coalesce with the metacarpals, as in the Chameleon. Their development is related to that of the digits with which they articulate. All the true proximal carpal ossicles may unite into one bone, as in *Pteropus*, and the whole carpus may be reduced to two distinct bones, as amongst Birds.

The *metacarpus*, when fully developed, consists of five rather long metacarpal bones, as in Man. There may, however, be but two, and these united into what is called a "canon bone" (as in Sheep, Deer, &c.); or there may be but a single one, as in the Horse,—answering to Man's third metacarpal. They vary in relative size and proportion in different animals, but are most remarkable for their length and slenderness in the Bats, while they are much elongated in the Horse and most Ruminants.

As to the *digits*, there may be but a single one, as in the Horse, or two, as in Ruminants and the Marsupial known as *Chœropus*. There may be three, as in the Rhinoceros, the Proteus, and in *Seps*; or there may be four. The digits are never certainly more than five (except by monstrosity), although in the Ichthyosaurus extra marginal bones along the manus give at least the appearance of more.

When a digit is wanting it is generally the pollex (thumb), as in Spider Monkeys, but it may be the fifth, as in Pterodactyles, or both fourth and fifth may be wanting, as in Birds. The pollex may be more or less opposable to the others, as in Lemurs, most Monkeys, and in Man, or two digits may be opposed to the other three, as in the Chameleon.

The second digit may be greatly reduced, as in the Potto, or the third may be disproportionally slender, as in the Aye-Aye, or thick, as in the Great Armadillo. The digits may be enormously elongated, as in the Bats, or short, as in the Mole and the Land Tortoises. They may be very imperfectly developed, as in Birds. They may be so united by dense tissue as to be quite incapable of separate motion, as in the Cetaceans. The bones of the fingers are called phalanges, and there are always three of them to each digit except the pollex, which has but two in all Mammals with the exception of certain Cetaceans, which have more. There may be as many as fourteen phalanges in one digit in *Globiocephalus*. The proximal row of these bones may become anchylosed to the metacarpals, as in the Three-toed Sloth. In Reptiles the numbers of the phalanges often increase from two in the pollex to five in the fourth digit, as in the Monitor. The abortive manus of Birds has at its best but three digits, with two phalanges to the pollex, three to the index, and one or two to the third digit. The phalanges are very numerous in the Ichthyosaurus and Plesiosaurus.

B. *Pelvic.*—The bone of the thigh is called the *femur*, and is a long bone which varies less in its form and proportion in different animals than does the humerus. It is, however, relatively very short in the Seals, and still shorter in the Ichthyosaurus.

In front of the knee-joint there is generally present a large sesamoid bone known as the knee-pan or patella. This, however, may even in Mammals be very small, as in Bats and Seals, or wanting altogether, as in the Wombat.

The leg below the knee is supported by two long bones, the *tibia* and the *fibula*, placed side by side, whereof the former is the more internally situated, the larger generally, and the more constant. The two bones may anchylose together at each end, as in the Armadillos, or they may do so only below or only above; the two bones may be completely fused together, as in the Frog. The tibia may be the only long bone, through the small development of the fibula, as in Ruminants and the Horse. The fibula may be quite styliform, as in Birds, or it may be developed inferiorly but be atrophied at its upper end, as in Bats. It may be represented only by a small ossification outside the lower end of the tibia, as in the Ox, and with this there may exist a styliform rudiment of its upper part, as in the Elk.

The joint by which the foot moves on the leg is situated between the lower end of the leg bones and the tarsus in Mammals and Amphibians. In Birds and Reptiles, however, this joint is placed in the tarsus, the proximal part of which is firmly connected with the leg, while its distal part is firmly connected with the metatarsus.

The *tarsus* of Man consists of seven irregularly shaped, more or less short bones. Of these the astragalus joins the tibia and has the os calcis beneath it and the naviculare in front of it, while the metatarsals are supported (from the great toe outwards) by the internal, middle, and external cuneiform bones and by the cuboides, which is connected with the fourth and fifth metatarsals.

The tarsus may have its parts more or less permanently cartilaginous, as in some Urodeles. The number of its bones, or cartilages, may be as many as nine, as in the Salamander, or be reduced to three, as in *Proteus*, or perhaps to two, as in *Ophiodes*. Two tarsal bones (the os calcis and naviculare) may take the form of long bones, as in *Galago* and especially in *Tarsius*. These two bones and the astragalus may be represented by a single bone, as in many Lizards, or may early unite with the tibia, as in almost all Birds. The astragalus may be represented by two bones, as in Urodeles. It may have an extra ossicle annexed to it, as in the male *Ornithorhynchus* and *Echidna*. Two extra ossicles may be attached to the tibial side of the foot, as in the true Porcupine (*Cercolabes*). The naviculare may anchylose with one of the distal tarsal bones, as in the Ox and Deer, where it unites with the cuboid. The distal bones are less constant than the others, and they may anchylose with the metatarsals, as in Birds, the Chameleon, and the Three-toed Sloth. The cuboid may be represented by two bones, as in certain Urodeles. The internal cuneiforme may be wanting, as in the Ox, or coalesce with the middle one, as in the Horse.

The *metatarsus* when fully developed consists of five rather long metatarsal bones, as in Man, and never of more. There may be but a single developed metatarsal, as in the Horse (the third) and *Chœropus* (the fourth), or two fused together, as in the Sheep, Deer, &c., or three fused together, as in the Jerboa, or four so fused, as in many Birds. There may be but two metatarsals well developed, as in the Hog, or three, as in the Rhinoceros, or four, as in the Dog. They are never enormously elongated like the metacarpals of Bats, but they may all be extremely short, as in Land Tortoises and the Ichthyosaurus.

The *digits* vary in number, as has just been indicated with respect to the metatarsal bones sustaining them.

When one digit is wanting it may be the fifth, as in Birds, or the hallux (first or great toe), as in the Hare. The third and fourth digits may be only functional ones, as in the Ostrich; but the third may abort, leaving only the fourth, as in *Chœropus*, or the fourth, leaving only the third, as in the Horse. The fourth and fifth may be the only functional ones, as in the Kangaroo. The hallux may be opposable to the other digits, as in Monkeys, Lemurs, Opossums, and Phalangers; or the first and fourth digits may be opposed to the second and third, as in Parrots; or the first and second to the third, fourth, and fifth, as in the Chameleon.

The phalanges of the digits are in Man's whole class always three to each digit except the hallux, which (like the pollex) has but two—save in the Orang, where it may have but one phalanx. They may be much more numerous than in Mammals, as in the pes of the Ichthyosaurus and Plesiosaurus. The numbers of the phalanges as we proceed from the first to the fifth digit may be 2, 3, 4, 5, 4, as in Lizards generally, or 1, 2, 3, 3, 2, as in the Salamander, or 2, 2, 3, 4, 3, as in the Frog. In Birds (where the fifth digit is more developed) the numbers of the phalanges, proceeding from the hallux, are mostly 2, 3, 4, 5; but they may be 2, 3, 3, 3, as in the Swifts, or 2, 3, 4, 3, as in the Goatsuckers.

Appendicular Skeleton of Fishes.

The Paired Limbs.—Most Fishes possess two pairs of limbs, known as the pectoral and ventral fins, which respectively correspond to the pectoral and pelvic limbs of higher Vertebrates. These limbs are attached to corresponding limb-girdles, whereof the pelvic girdle is always inferior in development and never attains the large relative proportions and fixed position of the pelvic girdle of non-Piscine Vertebrates.

Very often, however, the ventral fins are entirely wanting, and the pectoral fins are sometimes wanting also. In the latter case there is usually present more or less of a pectoral limb-girdle, though it may be, as in *Murænophis*, little more than a filament. In all non-Piscine Vertebrates the right and left limbs are symmetrically and equally developed, but in the Flat Fishes (*Pleuronectidæ*) one pectoral fin may be larger than the other, or one may disappear, as in *Monochirus*.

The situation of the paired limbs is, in Elasmobranchs, Ganoids, and a good many Teleosteans, similar to that they hold in higher Vertebrates, but in some other Teleosteans (such as the Fishes on that account called "thoracic") the ventral fins are placed far forwards so as to come immediately behind the pectoral fins, while in yet other Teleosteans (known on that account as "jugular" Fishes) they are placed even in front of the pectoral fins.

The *pectoral girdle* may consist of a simple cartilaginous arch, as in Elasmobranchs, or it may be composed, as amongst Teleosteans, of two bones meeting ventrally, each being commonly regarded as a clavicle which is continued up dorsally to the skull by the intervention of a supraclavicle and a post-temporal. Besides these there is a cartilaginous element on each side which usually ossifies in two pieces, the upper one of which is reckoned as representing a scapula and the lower one a coracoid. These parts are annexed to the inner side of the clavicle, where also there is sometimes found a styliform bone, more dorsally placed, called the post-clavicle.

The *pelvic girdle* is represented in Elasmobranchs by a transverse

cartilaginous structure formed of two separated or two medianly united pieces, each of which sometimes, as in *Chimæra* and *Callorhynchus*, shows much resemblance to the innominate bone of higher Vertebrates in that it sends up a process simulating (and probably representing) the iliac element and possesses a sort of obturator foramen. In Osseous Fishes the pelvic girdle is normally represented by two innominate bones medianly joined, each of which may, by rare exception, as in *Lophius*, send up a tall ilium-like process. In no Fish, however, does the pelvis become solidly united with the spinal column. In the cartilaginous Ganoids it is very rudimentary, and each lateral portion (which has a slightly-developed pubic and iliac process) is separated from its fellow on the opposite side, while in *Lepidosiren* there is only a single simple median cartilage with no iliac process.

The skeleton of the *pectoral limb*, or *fin*, of most Elasmobranchs consists of three considerable basal cartilages, placed side by side, articulating with the pectoral arch, and named the propterygium, the mesopterygium, and the metapterygium. Of these the propterygium is proximal or anterior in position. To the distal ends of these are articulated a number of slender elongated more or less segmented radial cartilages, and to the distal portions of these are annexed the horny fin-rays which form the solid supports of the distal portion of the fin.

Sometimes there may be but two and rarely only one basal cartilage, which one must then be considered as representing the whole three condifferentiated. In *Ceratodus* there is a single basal cartilage followed by a series of small cartilages—secondary radial cartilages diverging from both sides of that series and having fin-rays annexed to them. In *Lepidosiren* the limb skeleton is still more simplified, consisting only of a single series of short slender cartilages with small fin-rays attached to one side alone, without the intervention of any radial cartilages.

In some Bony Fishes (*e.g.*, *Polypterus*) the basal cartilages are more or less ossified, as are also most of the radials next them, while to these small cartilaginous radials are annexed, which support ossified fin-rays. In some other Ganoids certain of the radial cartilages articulate directly with the pectoral arch. In the *Teleostei* a few, not above five, more or less ossified cartilages lie side by side and articulate with the pectoral arch, and one or more rows of small cartilages succeed to them. These two elements represent the basal and radial cartilages of Elasmobranchs, and to them are articulated the relatively large fin-rays which make up the far greater part of the Teleostean pectoral limbs.

The skeleton of the *ventral fin* or *pelvic limb* is almost always more simple than that of the pectoral one. Only very rarely, as in *Ceratodus*, *Lepidosiren*, and *Callorhynchus antarcticus* (see *Trans. Zool. Soc.*, vol. x. p. 455, and plate lxxix. figs. 3 and 4), have they a close, or pretty close, resemblance. Generally the Elasmobranch ventral limb is supported by an elongated cartilage, the basipterygium, which articulates with the pelvic cartilages and bears on its ventral border a series of cartilaginous radialia with which the fin-rays are connected. In *Polyodon folium* there are only radials which support fin-rays but are not themselves supported by any basipterygium, nor is there any pelvic cartilage. In the *Teleostei* the fin-rays are directly attached to the osseous pelvic elements.

The Unpaired Appendicular Elements.—Besides the two pairs of limbs there are, as has been mentioned, certain azygous structures commonly known as the unpaired or azygous fins or limbs. They are only found in Fishes, and consist of the dorsal, caudal, and anal fins. These may all run one into the other and form a continuous fin fringe to the body from the head round the tail and forward again to the vent, as in Eels and many Gadoid and Blennioid Fishes. In most cases, however, there are one or two distinct dorsal fins, and an anal fin also distinct from the caudal one.

The structure of the *dorsal fin* in Elasmobranchs is singularly like that of their paired fins, inasmuch as it is supported by an elongated or segmented basal cartilage or cartilages, from the dorsal margin of which radial cartilages (generally elongated, slender, and segmented) proceed, having the fin-rays connected with them distally. The basal cartilages may or may not be directly connected or become continuent with the subjacent spinal skeleton. There may be (as in the second dorsal of *Callorhynchus antarcticus*) but a single longitudinal series of more or less elongated cartilages side by side, like radial cartilages devoid of any subjacent basal cartilages. In the *Teleostei* the fin-rays may be osseous and in the form of more or less strong spines, or soft and of a horn-like consistency, and segmented both vertically and horizontally; and fin-rays generally consist of two (right and left) halves, which, although closely applied together for the greater part of their length, diverge proximally to embrace the skeletal element to which they are annexed. These latter elements in the *Teleostei* are small ossicles or chondrifications, termed "interspinous bones or cartilages." They extend upwards between the neural spines of the axial skeleton and the dorsal surface of the body.

Anal fins are essentially similar in composition to dorsal fins.

The *caudal fin* is modified according to the condition of the posterior termination of the axial skeleton, the different condition of which in Fishes has already been noticed (p. 112). Much-modified axial elements generally form the support of the fin-rays, but the numerous complex and varied conditions which these parts may present in different forms is a matter of ichthyology, which can hardly find a place in a general description of the Vertebrate skeleton.

Nature and Origin of Appendicular Skeletal Parts.—From the researches of the late Prof. Balfour it appears that the paired limbs arise as differentiations of continuous lateral folds or projections from the surface of the body, and the azygous fins arise as differentiated projections from its dorsal and ventral surfaces. Thus all these appendicular parts may be viewed as different species of one fundamental set of parts (pterygia), for the sum total of which the term "sympterygium" has been proposed (see *Trans. Zool. Soc.*, vol. x. pp. 481, 482). The paired limbs and azygous fins are of similar origin and nature. Separate narrow solid supports, in longitudinal series, and with their long axes directed more or less at right angles with the long axis of the body, were developed in varying extent in all these four folds or projections. These supports have, it would appear, very often united to form basal cartilages, the original single and united condition persisting in such forms as the ventral fin of *Polyodon* and the second dorsal of *Callorhynchus*, both already noticed.

The paired limbs are thus, in all probability, essentially peripheral structures which have become more or less closely connected with the axial skeleton. Their proximal parts uniting and growing inwards have often become directly connected with parts of the axial skeleton. Thus the limb-girdles seem to have arisen,—namely, as ingrowths from the basal cartilages of the limbs; and therefore the whole appendicular skeleton belongs to a different skeletal category from that of the head and spinal column or axial endoskeleton.

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SKELTON, JOHN, an eccentric English scholar and poet of the 15th century. Mr Dyce, the editor of his works, fixes his birth about 1460. His first essay in verse was a poem after the manner of Lydgate on the death of Edward IV. (1483). He lived to pay compliments to Catherine, wife of Henry VIII., to jeer at the Scotch over the battle of Flodden, and to make fierce attacks on Wolsey, and is supposed to have died in 1529. In general intellectual force, fierceness of invective, wildness of buffoonery, and coarseness of language Skelton bears some likeness to Swift. But he stands by himself as one of the most eccentric and paradoxical characters in English literature. He began life apparently as the protegé of a pious, learned, and literary lady, the mother of Henry VII., who founded St John's College and Christ's College, Cambridge, and translated devotional works from the French. He was himself one of the most notable scholars of his time, was appointed tutor to Henry VIII., was