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 *Paia 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 (manns 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 corre­

spondence 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 there 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.