

shoulder blade. The upper arm consists of one bone, the lower arm of two bones, and the wrist of a group of irregular small bones. Beyond these there are five chains of bones set end to end to form the body of the hand and the digits. Among the least specialized of the arms of other vertebrates is that of the frog. Its shoulder girdle contains a third bone on each side which forms the chief brace of the arm against the breast bone. The arm itself differs from the human arm chiefly in that the two bones of the lower arm are fused side by side, the small bones in the wrist are less numerous, and there are practically only four rows of bones in the hand with somewhat different numbers of bones in them. In the sea turtles the fore limb is externally a long flat paddle, not divided in the flesh into separate fingers at the end. Yet, with the exception of the inflexibility of some of the Joints, the bony structure within, even to the number of segments in the digits, is essentially the same as in many land vertebrates. The arms of whales are likewise flat and without separation of the digits in the flesh but their skeletons differ from typical vertebrate arms almost only in the absence of a collar bone, the immovability of the elbow joint, and an increase in the number of bones in the digits. In bats, the principal modification is the great elongation of the bones of the body of the hands and the fingers (except the thumbs) to form the framework of the wings. One of the bones of the lower arm is rudimentary; otherwise the arm skeleton is typical. In birds the wing is formed, not by an extension of the digits, but notwithstanding a great reduction of them. There are only three fingers, and each of these has one or two fewer bones than the corresponding fingers of man. The expanse of wing thus lost is more than compensated by very stiff feathers. The only other striking difference between the bird wing and a typical vertebrate forearm is the reduction of the separate wrist bones to two. In the forefeet of horses there is only one well-developed chain of bones instead of the usual four or five, while two others are represented by the single splint bones on either side. The single toe in these animals is generally held to be in the interest of speed. In snakes the forelimbs are completely wanting, though the other skeletal characters show many resemblances to other vertebrates.

"The hind limbs show somewhat fewer and less striking departures from the ordinary. In sea turtles and horses their modifications are of about the same kind and degree as those of the forelimbs. In most whales they are entirely missing, though in a few there are small bones embedded in the flesh in the pelvic region without any connection with the spinal column, which are usually homologized with the hip girdle. In most snakes, likewise, hind legs are wholly wanting. In a few (including the python and the boa), hind legs are externally visible only as clawlike structures scarcely protruding beyond the general level of the scales on the surface. Connected with these claws internally are rudimentary bones representing the girdle and probably one or more of the leg bones."

-- A. Franklin Shull, *Evolution* (New York: McGraw-Hill Book Company, 1936), pp. 18-23.