

A Study of Bird Flight

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FIG. 14 represents diagrammatically the structure of the wing tip, A-B is the axis of the wing, I to X are the large wing tip feathers, usually known as the primary quills. Of these I to IV are attached

indicated at E. The phalangeal quill mass is articulated at the point, H, to the point, F, of the metacarpal mass. That is to say, E is the carpal joint, and H and H represents the metacarpal joint.

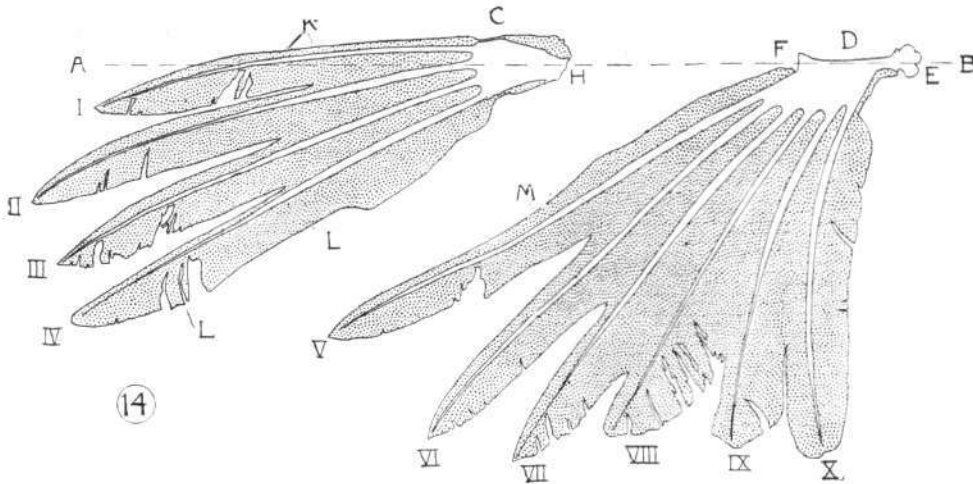


Fig. 14.—Structure of wing-tip of vulture. A—B, axis of wing. C K L, phalangeal quill mass, consisting of first four primary quills, I, II, III, IV, which form an almost solid mass with the phalangeal bone mass, C. The phalangeal quill mass is articulated at H to the point, F, of the metacarpal quill mass, M D. This latter consists of the fused metacarpal bones, D, to which are firmly attached the remaining primary quills, V, VI, VII, VIII, IX, and X. These quills may conveniently be termed metacarpal quills. The metacarpal quill mass is articulated at E, the carpal joint to the main part of the wing. For the sake of clearness, the alula or bastard wing has been omitted.

to the phalangeal bones, C, forming therewith a practically solid mass. These first four quills may conveniently be described as the "phalangeal quills." The remaining primary quills (V to X) are similarly attached to the metacarpal bone, D. These quills may, therefore, be described as the "metacarpal quills." The point of attachment of the metacarpal quill mass to the rest of the wing is

indicated at E. The phalangeal quill mass is articulated at the point, H, to the point, F, of the metacarpal mass. That is to say, E is the carpal joint, and H and H represents the metacarpal joint. If the wing is extended horizontally, movement at these two joints may take place in the horizontal plane by the action of various flexor and extensor muscles. In birds there is no muscle that can bend the wing tip downwards by direct action. As I shall show in a later chapter, in bats there is such a muscle, which can bend the wing downwards at the carpal joint, and is used in flapping flight at the end of each downstroke. In birds, any appearance of bending downwards at the carpal joint can only be due to indirect causes, such as pressure of air on the upper surface of the wing. Slight rotation round the axis of the wing can occur at the carpal and metacarpal joint, and is so produced by the muscles that I am about to describe.

Let us suppose that the diagram (Fig. 14) represents the two parts of the wing-tip of the left wing as seen from above. The arrangement is such that the inner feathers overlap the outer feathers. That is to say, for instance, the edge M of quill V overlaps the edge L of quill IV. In the case of the common vulture when making a dip movement of limited extent, a gap of about an inch may be seen to occur momentarily between the points M and L. Therefore the rotation of the point K downwards

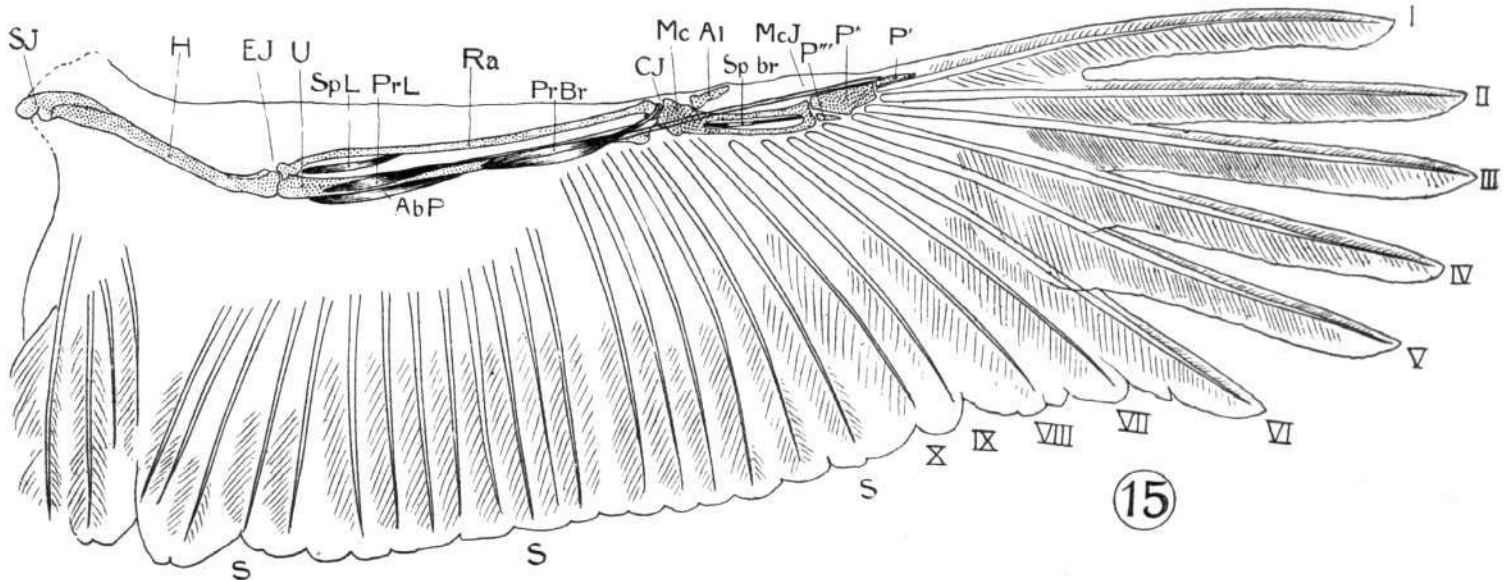


Fig. 15.—Dissection of left wing of Black Vulture (*Otogyps calvus*) seen from below, showing muscles concerned in rotation of wing-tip. SJ, shoulder joint; H, humerus; EJ, elbow joint; U, ulna; Ra, radius; CJ, carpal joint; Mc, metacarpal bone; Al, phalanx of first finger of alula; McJ, metacarpal joint; P, P', phalanges of middle finger; P'', phalanx of third finger. I, II, III, IV, phalangeal quills; V, VI, VII, VIII, IX, X, metacarpal quills; S, S, S, secondary quills; Sp L, supinator longus; Sp br, supinator brevis. The tendons of these two muscles are not shown. Pr L, pronator longus; Ab P, abductor pinnae; Pr Br, pronator brevis. The tendons of the pronator longus and of the abductor pinnae are shown inserted into the phalanx P'.