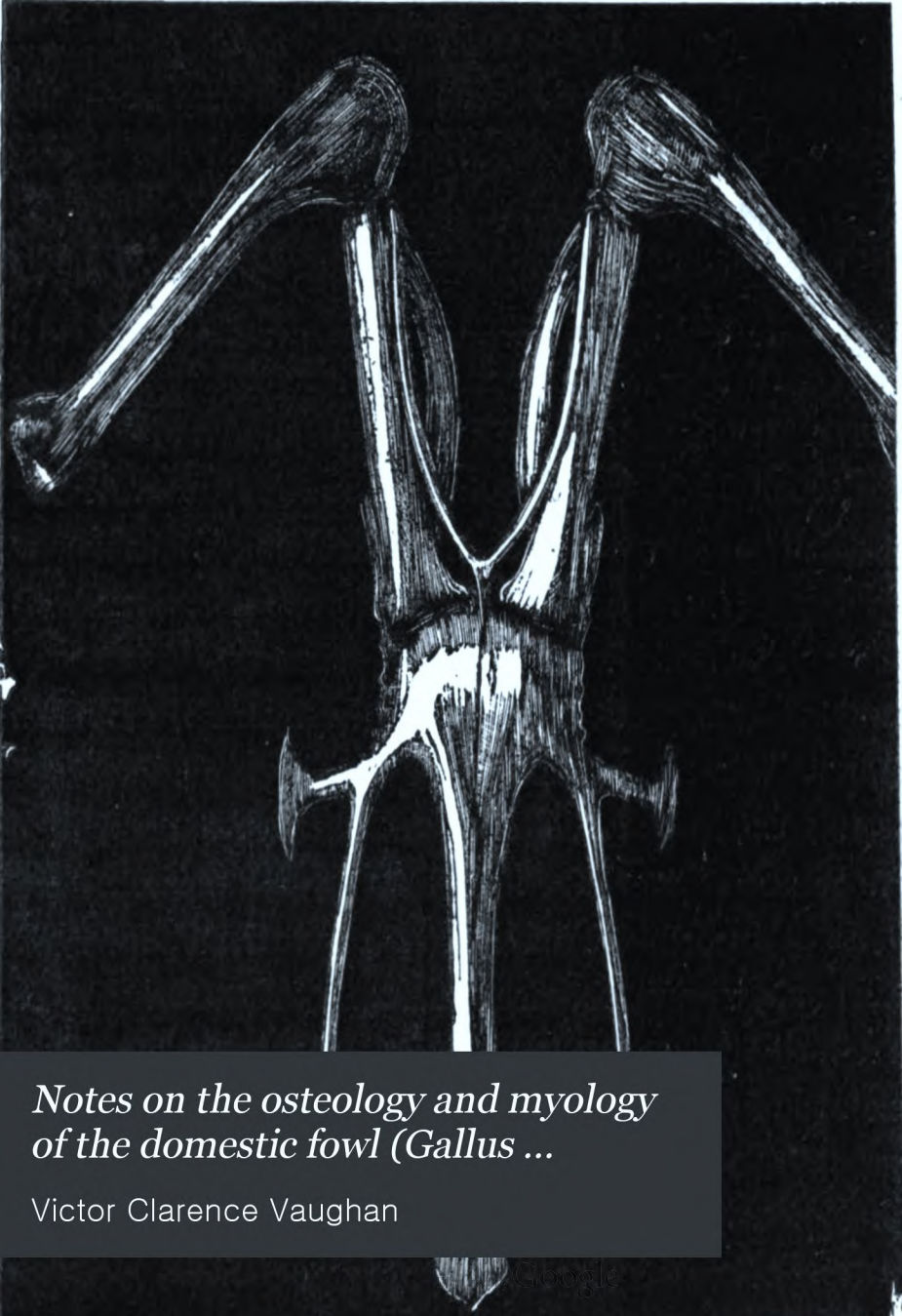

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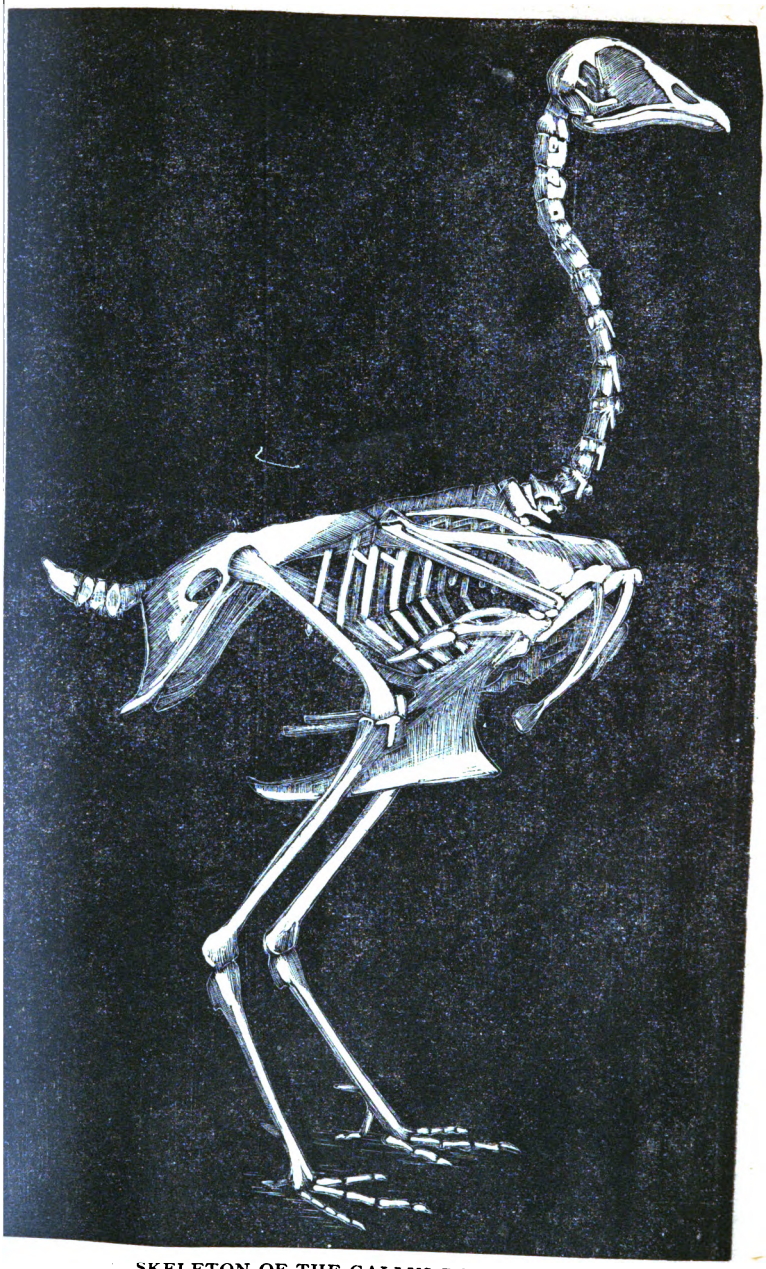
Victor Clarence Vaughan



SKELETON OF THE GALLUS DOMESTICUS.

NOTES

ON THE

OSTEOLOGY AND MYOLOGY

OF THE

DOMESTIC FOWL,

(*Gallus Domesticus*,)

FOR THE USE OF COLLEGES AND SCHOOLS OF COMPARATIVE ANATOMY AND FOR THE INDEPENDENT ZOOLOGICAL STUDENT.

BY

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PREFACE.

The author, both as a student and a teacher, has long felt the need of a plain, practical work on the anatomy of some common animal. For this reason, he has chosen the domestic fowl and has endeavored to give such descriptions of its bones and muscles as will enable the student to extend his work and gain a knowledge of the anatomy of birds in general. The range of comparative anatomy is unlimited and many valuable books have been written in this department; but the majority or all of these books are general, large and expensive, or are devoted to the anatomy of some rare animal. To teach or to try to teach anatomy without practical work, without having the object before the student, is acknowledged by all who have tried it, to be but little better than a waste of time.

In this work, the common order of arrangement has been departed from to some extent. In the Osteology the bones of the skull instead of being given first, are reserved for the last. This has been done because these bones are more closely united and consequently cannot be studied by the beginner so easily as some of the other bones. For the same reason the muscles of the limbs have been described before those of the back, neck and head are studied.

The descriptions of the bones and muscles have been made from the common fowl, but the student should dissect and study at least one specimen from each of the different orders of birds.

The references which have been used, are Brown's "*Klassen und Ordnungen des Their-Reich*," Owen's "Anatomy of Vertebrates," Huxley's "Vertebrated Animals," and "Elements of Comparative Anatomy," and a paper on the "Osteology of the Colymbus Torquatus," by Coues. These works have been used freely.

The author gladly avails himself of this opportunity to express his sincerest thanks to that able comparative anatomist, Dr. Abram Sager, who has had the kindness to examine that part of the manuscript relating to the bones of the head. Especial thanks are also due to Prof. Harrington, of the University of Michigan, for his valuable suggestions.

Hoping that this may be considered an effort in the right direction, and that it may supply a need greatly felt by all teachers of natural science, the author presents this little book to the kind consideration of all those who are interested in the subject.

ANN ARBOR, JULY, 1876.

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PART FIRST.—OSTEOLOGY.

PART SECOND.—MYOLOGY.

OSTEOLOGY.

THE SKELETON.

The skeleton of birds is singularly compact and light. The compactness is due to the fact that the bones contain an unusual quantity of phosphate of lime; while the lightness is caused by the absence of marrow and the presence of air in its stead, in some of the bones. Upon making a transverse section of one of the long bones, the humerus, for instance, of the domestic fowl, the outer, compact part of the bone will be found to be very thin; while the interior contains a cancellated structure with large intervening spaces. The bones of the skull are so closely united in the adult, that it is difficult to define the limits of each bone. The cervical region is long and flexible, in order to secure the greatest freedom of motion to the head. The neck is sufficiently long to allow of the application of the beak to any part of the plumage, for the purpose of cleaning and oiling the same. The vertebræ of the dorsal and sacral regions are, for the most part, immovably articulated to each other; but those of the caudal region admit of the same variety of motion as those of the cervical region. The ribs, which number seven pairs in the domestic

fowl, give off a peculiar process, which lies over the next rib. In front the ribs meet with the sternal ribs, which are straight bones, passing from the costal border of the sternum upwards and backwards. The sternum of the fowl is not so strong as that of birds of flight; but is deeply cut by wide indentures. The anterior extremities terminate in three fingers, and the hand is not used as an organ of prehension. The two halves of the pelvis are united with each other, and with the sacral vertebræ. The femur is short, and the principal bone of the posterior extremities is the tibia. The tarsal and metatarsal bones are fused so as to form one bone, the tarso-metatarsus. The foot consists of four toes, three of which are anterior and one posterior. The entire skeleton of the domestic fowl consists of one hundred and sixty-one (161) bones. These are as follows:

Bones of the head,	29
Vertebral column,	42
Os hyoides, sternum and ribs,	16
Bones of scapular arch,	6
Anterior extremities,	26
Posterior extremities,	42
	161

The bones of the head may be divided into two classes, as follows:

Skull,	15
Face,	14
	29

The vertebral column is divided into four regions:

Cervical vertebræ,	14
Dorsal vertebræ,	7
Lumbar and sacral vertebræ,	14
Caudal vertebræ,	7
	42

The sixteen bones which are given for the os hyoides, sternum and ribs are as follows:

Os hyoides,	1
Sternum,	1
Ribs,	14
	16

The bones of the scapular arch are:

Clavicles,	2
Coracoids,	2
Scapulas,	2
	6

Each of the anterior extremities has the following divisions:

Arm,	1
Fore-arm,	2
Carpus,	2
Metacarpus,	3
Phalanges,	5
	13

Each division of one of the posterior extremities consists of the following number of bones:

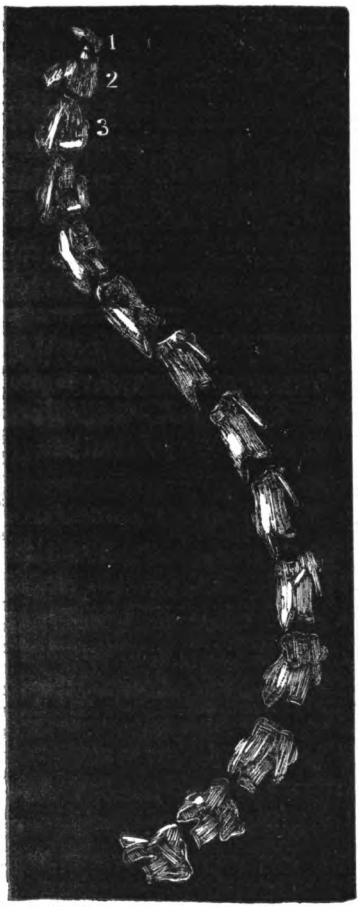
Pelvis,	1
Thigh,	1
Patella,	1
Leg,	2
Tarso-metatarsus,	1
Metatarsal,	1
Phalanges,	14
	21

THE VERTEBRAL COLUMN.

The vertebral column is articulated anteriorly to the head; it extends along the neck, through the upper and middle part of the body, terminating in a point at the posterior extremity of the animal. It serves as a pillar to which the

frame work is attached, thus giving firmness to the entire body, and protecting the delicate organs of life. It is composed of a number of short, hollow, cylindrical bones, placed end to end, so as to form a tube which contains an important portion of nervous matter, the spinal cord. These short bones are called vertebræ. They vary much in size and shape according to their position in the column. These differences are so great as to require us to divide the vertebral column into four regions. These groups are, beginning anteriorly, 1st. Cervical; 2d. Dorsal; 3d. Lumbar and Sacral; 4th. Coccygeal. The cervical vertebræ are fourteen in number, and form the osseous portion of the neck. They are easily movable upon one another, thus allowing great freedom in the movements of the head. This is necessary in taking food and in shifting the center of gravity during flight.

FIG. 2.—CERVICAL VETEBRÆ.



1. Atlas. 2. Axis. 3. Third Cervical.

The dorsal vertebræ number seven, and are generally consolidated into a single piece. The ribs are attached fo these and they give strength to the body. The lumbar and sacral vertebræ number fourteen and are so joined that it would be difficult to decide where the lumbar region ends and the sacral begins. The coccygeal are movable upon one another, thus allowing the tail to be used as a rudder during flight.

The opening through each vertebra from end to end, is called the spinal foramen. That portion of the vertebra beneath, and forming the floor to the spinal foramen, is the body of the vertebra. The other portion is named the annular part; because it encircles the foramen.

The body presents for study two extremities, anterior and posterior, and two faces, superior and inferior. The anterior extremity of the body has a facet, which is concave laterally, and convex vertically; while the posterior extremity has a facet which is convex laterally and concave vertically. The posterior facet of the body of one vertebra, fits into the anterior facet of the succeeding one. The superior face of the body forms the floor of the spinal foramen. It is smooth and concave from side to side. The inferior face is more or less uneven and convex from side to side. In most of the vertebræ, it is divided into two lateral halves, by a thin process, the inferior spinous process. The annular portion presents an internal and an external part, and an anterior and a posterior border. The internal surface forms the walls and roof of the spinal foramen. This surface is smooth, and more or less arched. In some vertebræ, the walls are more nearly perpendicular and the roof is flatter than in others. The external surface of the annular portion is rough and consists of two sides and a

crest. The crest is marked by an elevation more or less prominent, and called the superior spinous process. The spinous processes of the dorsal vertebræ are united so as to form a continuous ridge. This process, also the inferior spinous process, is for the attachment of muscles, which pass from one vertebra to the other. The anterior border of the annular portion is deeply concave from side to side. The lateral prolongations of this border are called the anterior articular processes. Each of these is furnished with a smooth, slightly convex facet which looks upwards and inwards. [The description of the vertebræ given here should be studied with the cervical vertebræ, since they are separated from one another, and for this reason, the description is given more directly concerning them.] The posterior border has three concavities, two lateral, one between each side of the body and the corresponding articular process, and the third above, between the two processes. The posterior articular processes are furnished with facets which look downwards and outwards. When the vertebræ are in position, the openings forward by the concavities in the borders are called intervertebral notches. The processes which come off from the sides of the annular portion of the vertebræ are called transverse processes. The transverse, as well as the other processes, vary greatly according to the position of the vertebra in the column. The transverse processes of the dorsal vertebræ are generally consolidated, while the same processes in the cervical vertebræ are rough tubercles, coming off under the anterior articular processes, pierced at the base by a foramen, and sending backwards, parallel with the body a styloid projection, which varies in length and strength according to the position of the vertebra to which it belongs.

SPECIAL DESCRIPTION OF SOME VERTEBRÆ.

The Atlas.—This, the first bone of the column, and that to which the head is directly attached, is a thin ring and easily distinguished from any other vertebra in the column. It has no transverse processes, and no anterior articular processes, save that which marks the body.

The Axis.—This is the second cervical vertebra. It presents a well developed odontoid process, under which is a facet for articulation with the body of the atlas. There are no transverse processes and a small groove represents the former which pierces the base of the transverse processes of the succeeding vertebræ. The superior spinous process is short, thick and blunt.

Third and fourth Cervical.—These two resemble each other closely. Their transverse diameter is greater than that of either the preceeding or succeeding vertebræ. The expansion is on the sides of annulur portion and is pierced by a vertical foramen—one on each side. Both have transverse processes with short styloid prolongations. The superior spinous process of the third, points backwards, while that of the fourth points more directly upwards, and that of the fifth points slightly forwards. Beyond the fourth cervical, the vertebræ increase in length, the styloid projections from the transverse processes, become longer and more pointed, and the posterior articular processes are long and diverging until the eighth or ninth cervical is reached. Beyond these the vertebræ decrease in length and increase in thickness to the dorsal. In the last cervical, the transverse process is but an arch enclosing a larger foramen. In the last three cervical and the first dorsal, the inferior spinous process is

well developed and is inclined forwards. The change from the cervical to the dorsal, can at once be recognized by the absence of the foramen which pierces the base of the transverse process in the cervical. This foramen is very large in the last cervical, but absent in the dorsal. In the latter, there is a foramen along each side of the vertebræ but this foramen is formed by the ribs, each of which unites with its vertebra in two places. The first and last dorsal can generally be separated from the others. But the superior spinous processes, the bodies, transverse processes and often the inferior spinous processes of the other five have grown together so completely as to form one bone.

The lumbar and sacral vertebræ are united to one another and to the bones of the pelvis. But the line of union between the bones of the pelvis and these vertebræ is generally quite distinct.

The coccygeal vertebræ are movable upon one another. They are seven in number and are easily recognized from those of the other regions. The first one is united with the sacral. It has broad transvers processes and a long arch enclosing a foramen, represents the superior spinous process. None of the coccygeal vertebræ have the inferior spinous process.

The succeeding five vertebræ have well developed transverse processes, those of the second being the broadest and those of the fifth and sixth being the longest. These transverse processes are smooth, thin and slope downwards. These vertebræ also have prominent superior spinous processes, which are bifid, pierced at the base by a foramen and decrease in size from before backwards.

The seventh coccygeal, or last bone of the column is quite

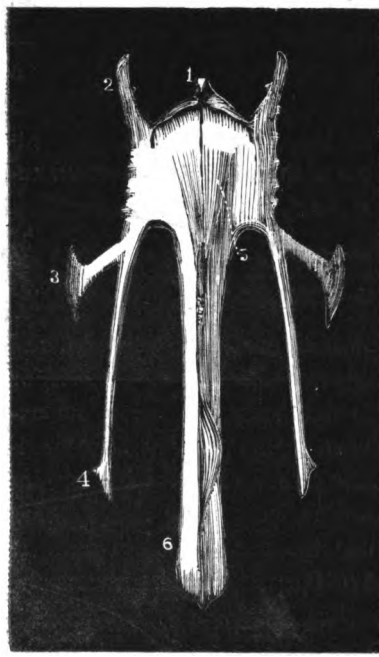
different from any other vertebra. From its peculiar shape, it is known as the plough-share bone. It is long, turned upwards and comes to a point at its posterior extremity. Anteriorly on its superior edge, there are two short protuberances, which represent the bifid superior spinous processes of the preceding five coccygeal vertebræ. It has no transverse processes. Its inferior edge is rough, convex longitudinally, and is marked toward its anterior end by a medium groove. This bone is formed by the union of two or more bones. It supports the oil-glands and gives attachment to the quill feathers of the tail. It is entered anteriorly by the termination of the spinal foramen.

THE STERNUM—BREAST BONE.

This bone forms the floor of the abdominal cavity, and supports the viscera. The general form of its interior or upper face is concave; while the general shape of its external or lower face is convex, both latterally and longitudinally. We shall consider this bone as consisting of a body and eight processes. The body is the thick, strong part of the bone, from which the processes pass out. It constitutes the anterior part of the bone, and presents for study two faces with their borders. Projecting from the middle potnt of the anterior border of the body, is a short, thin process, which is pierced at its base by foramen. This process is the manubrium. On each side of the base of this process, is the facet for the articulation of the coracoid bones with the sternum. These facets are convex from side to side, and concave from above downwards. The two facets join, forming the foramen, which pierces the base

of the manubrium, so that the two form a depression along the entire anterior border of the body. Directly over the extremities of this depression arise the anterior costal processes, which extend forward and upward.

FIG. 3.—STERNUM.



1. Manubrium. 2 Anterior Costal Process. 3. Posterior Costal Process. 4. Lateral Process. 5. Body. 6. Posterior or Keel-bearing process.

These processes present two faces, an internal and an external, and two edges, a superior and an inferior. About half way up the miner face is a small protuberance, from which the surface slants, both towards the base and towards the extremity of the process. The external surface is slightly concave and more or less marked by lines passing from the superior edge forward and across to the inferior edge. The inferior edge is smooth and concave, the superior more or less rough and convex. From the base of the anterior costal process backwards, the border of the body is called the costal border, and is occupied by the facets for the articulation of the sternal ribs. Sometimes one of the facets lies up on the posterior edge of the anterior costal

process. At the posterior extremity of the costal border, the lateral process extends backwards nearly parallel with the posterior process, which bears the keel. From the superior edge of the base of the lateral process, arises the posterior costal process, which extends upwards, backwards and outwards. The faces and edges of the posterior costal processes are smooth and even. At its extremity this process spreads out fan-shaped, and is thin. The long lateral process—one on each side of the posterior process—extends backwards and slightly upwards. Its length is about five-sixths of that of the posterior process, its inner face is smooth, its outer, convex from side to side. Near its extremity there is a slight protuberance on the superior edge of this process. From the base of the lateral process to the base of the posterior or keel-bearing process, the margin of the body is thin and often pierced by one or more very small foramina. The posterior or keel-bearing process is the largest and most prominent part of the bone. It arises from the middle of the posterior margin of the body, and extends backwards and slightly upwards. The internal or superior face of this process forms a smooth, shallow trough, which slopes from the posterior extremity to the base of the process. Just at the base will often be found a small foramen. The external or inferior face, is convex both laterally and longitudinally, and is mostly taken up by the keel, which arises from its median line. The keel is the prominent part of the bone, projects downward, and serves for the attachment of the pectoral muscles. It gradually decreases in prominence from the base to the extremity of the process. It presents two faces, both lateral, one edge, the inferior and one end, the anterior. The faces are smooth

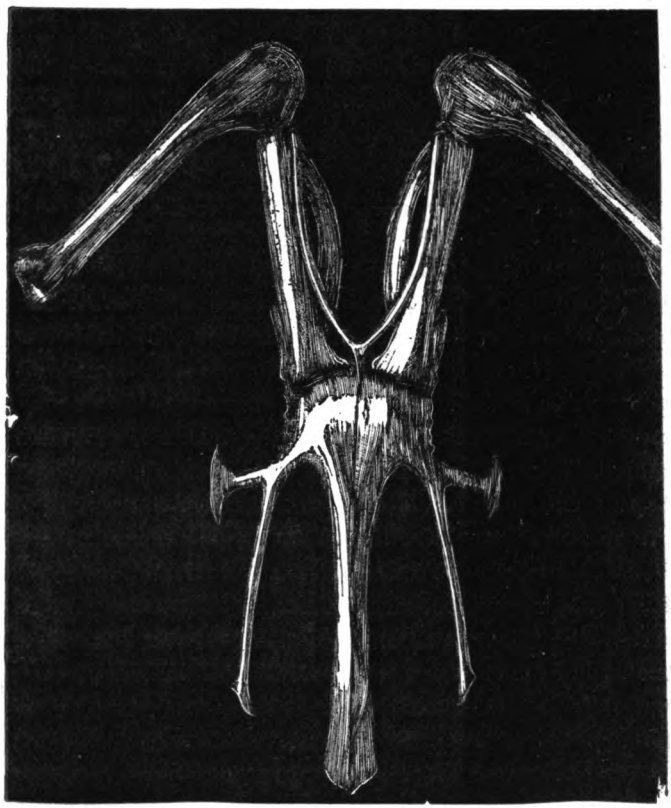
and even. The edge is rough and thick anteriorly, smooth and thin posteriorly. The edge is seldom or never straight, as the bone has been pressed to the one side or the other somewhere along its margin. Anteriorly the origin of the keel is shown on the under surface of the body by two eminences with a depression between. These pass backwards and downwards (holding the bone in its natural position), then unite and pass forward and downward, so as to form a beak to the most prominent portion of the keel.

THE CORACOID.

These bones lie behind the clavicle. They rest upon the sternum and form the chief support for the shoulder. They join the sternum in the two facets which mark the anterior border of the body of that bone, and which unite to form the foramen piercing the base of the manubrium. From the sternum, these bones pass forward and upward, being articulated above with the scapula, humerus and clavicle. The anterior or external face of the coracoid is strongly convex and increases in width toward its sternal extremity. Its posterior or internal face is rough and slightly concave toward the sternal extremity. The articular facet on the anterior border of the body of the sternum, into which the lower extremity of the coracoid fits, is convex from side to side and consequently there is a depression in the end of the coracoid bone, corresponding to the convexity in the facet. This depression is not median, but much nearer the inner edge of the bone, the internal projection being smaller and shorter than the external. The internal projection passes into the foramen under the menubrium, where it meets the corres-

ponding projection of the other coracoid. The external projection is large and extends out even beyond the limit of the

FIG. 4.—STERNUM AND BONES OF SCAPULAR ARCH.



facet and partly covers the external face of the anterior costal process. The upper extremity of the coracoid is quite irregular. The scapula passes along almost parallel with

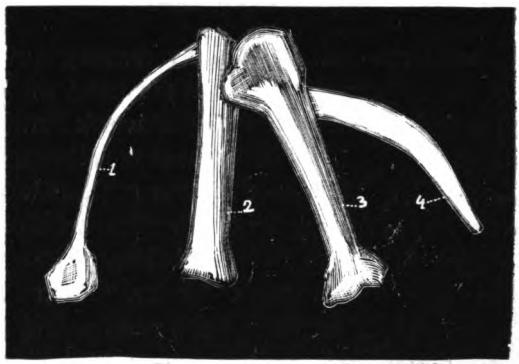
the vertebral column and articulates with the posterior or internal face of the coracoid. The scapula, thus acts as a brace, not allowing the upper extremity of the coracoid to be forced backward too far. The extremity of the scapula which fits against the coracoid, bears a median depression into which the coracoid sinks, and two projections—one on each side of the depression. The external projection is short, large and forms about one-third of the facet for the articulation of the humerus; the other two-thirds of the facet being formed on the outer edge of the coracoid. Above the facet for the humerus, the coracoid terminates in a protuberance which bends inwards coming directly over the internal projection of the extremity of the scapula, to which it is joined by a strong ligament. A notch, or with the ligament a foramen, is thus formed. The floor of this notch or foramen is smooth, and over this passes the long, strong tendon of the pectoralis minor to be inserted into the humerus. The clavicle is attached by a ligament to the point of this extremity of the coracoid. On the anterior face of the coracoid just above the facet for the humerus is a depression formed between the rough and raised border of the facet and the protuberance which bends inwards. There is also a slight depression on the end of this protuberance and the end of the clavicle fits into this depression.

THE SCAPULA.

This is a long, thin bone, which lies almost parallel with, and about an inch from the dorsal vertebræ. It rests upon the ribs and terminates anteriorly against the coracoid. Its posterior extremity is flat and narrow, but never terminates

in a point. Its anterior half or two-thirds is thick and strong. Its superior edge is thick anteriorly, thin posteriorly,

FIG. 5.—BONES OF SCAPULAR ARCH.



1. Clavicle. 2. Coracoid. 3. Humerus. 4. Scapula.

and strongly convex. From the anterior extremity of the bone, the superior edge passes back in almost a straight line, for about two-thirds the length of the bone; it then turns downwards. The inferior edge is smooth and concave. The posterior part of the bone is bent not only strongly downwards, but slightly outwards. The anterior extremity, as has been mentioned in describing the coracoid, bears a median depression and two lateral projections. The external projection assists in forming the glenoid cavity, while the external passes behind the coracoid and is attached by a ligament to the clavicle thus forming the foramen triosseum. The three bones, coracoid, clavicle and scapula form a strong support for the arm. The coracoid, the strongest of the three, acts as the direct support. The scapula prevents the displacement of the coracoid in an antero-posterior direc-

tion, while the clavicle hinders the displacement of the coracoid laterally.

THE CLAVICLES.

These bones are united inferiorly, forming the "wish-bone" or "merry-thought." From the point of union, a short, thin, wide, process extends backwards towards the sternum, but is not attached to that bone only ligamentously. This short process presents two faces, lateral, and a border, which is thin above and thick below. The process is often almost circular. From this process, the clavicles pass, at first, forward and upwards, then almost directly upwards to the corresponding extremities of the caracoid. Through the greater part of their length, tbese bones are smooth, and a transverse section would be nearly circular. The upper extremtremtty of each clavicle is flattened out somewhat, so as to offer two faces, an external and an internal. The external, face is smooth and slightly concave; the internal smooth and slightly convex. These bones are the most variable of the bones of the scapular arch. In the tame goose the clavicles are united, but do not send back a process from the point of confluence as in the chicken; while from the point of union, they extend first forward and downward, then upward and backward. The clavicles of the goose are much broader and stronger than those of the chicken. In the lat-

FIG. 6.—CLAVICLES.

ter the shape of the "wish-bone" or two clavicles united is that of the letter V, while in the former the form more nearly resembles that of the letter U. In the goose the extremities of the clavicles are not widened, but terminate in points: while about one-third of the distance from the point to the union, there is a small protuberance on the anterior edge of each clavicle.

ANTERIOR EXTREMITIES.

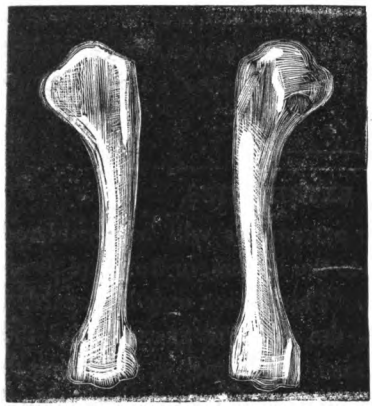
The bones of the anterior extremities will be considered in order from the shoulder to the fingers, or from the proximal to the distal extremity. This region may be regarded as consisting of three parts, the arm, the forearm, and the hand. There is only one bone, the humerus, belonging to the arm. The forearm contains two bones, the radius and the ulna. The skeleton of the hand consists of the carpal bones, two in number, of the metacarpal, three, and of the phalanges or bones of the fingers.

THE HUMERUS.

This, the first bone of the wing is especially characterized by the form of its extremities. The side of the bone next to the body is called the "anconal" side while the opposite one is called the "palmar." Besides these faces, the side or border corresponding with the position of the radius, is called the radial side or border, and the one corresponding with the ulna is called the ulnar side or border. The two extremities of the bone are slightly inclined forward, so that the general shape of the ulnar side is concave. The radial face is nearly straight along the upper two-thirds

the length of the bone, but is slightly concave in the lower third. The shaft is smooth, and a transverse section of it would be sub-eliptical. The ends of the bone are expanded, the proximal being the broader of the two. The palmar face of the proximal end is marked along the radial side by the superior crest, which affords an eminence for the insertion of the broad tendon of the great pectoral muscle. Directly in front of this crest, is a small depression, along which the long head of the biceps passes, and which is called the bicipital fossa. From this fossa across to the ulnar side, the palmar face is smooth, convex and extends out over the inferior crest. It is along this smooth, convex extended surface that the short head of the biceps takes its origin. The anconal face of the upper extremity is rough; its most noticeable feature being a foramen which passes into the interior of the bone. This foramen is known as the Foramen Pneumaticum of the Humerus. Above and along the ulnar border of this foramen is a crest, the inferior crest. It serves for the insertion of several muscles. The extreme proximal end of the humerus is a smooth, rounded or semi-oval convexity, the transverse diameter of which is the longer. It fits loosely into the glenoid cavity, being attached by ligaments. It is not separated from the rest of the bone by a

FIG. 7.—HUMERUS.



Anterior view. Posterior view.

neck or constriction. The entire proximal extremity of this bone bends downwards and inwards. The distal extremity presents on the palmar face, two articular surfaces, and a small sub-triangular concavity above them. The two articular surfaces are convex and the radial is the larger of the two. The radial articular surface arises about the middle of the bone, in the sub-triangular concavity and passes obliquely to the radial corner. There is a slight depression between this articular surface and the next or ulnar one, which lies farther toward the ulnar side and does not extend so far up into the concavity as the preceding one. Beyond the ulnar condyle there is a third eminence, but this one projects on the anconal face of the bone. On the anconal face there is another eminence. It is much smaller than the preceding and seems to be a continuation of the radial condyle. Between these two eminences on the anconal face, is a smooth, shallow depression in which the olecranon process of the ulna moves.

THE ANTIBRACHIUM.

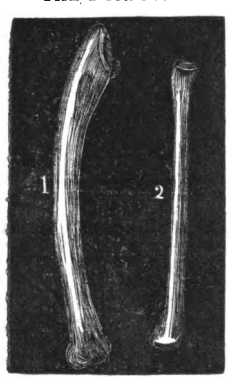
The forearm consists of two bones, the radius and the ulna. The ulna is much the larger and stronger of the two. The position of the ulna with respect to the radius, is posterior in the expanded wing, and exterior when the wing is folded. The bones are attached to each other at the two extremities in such a manner as to allow but little or no rotation. This is necessary, in order to give great firmness and power of resistance to this part of the wing during flight. The forearm is equal, or nearly so, in length, with the arm, so that when the wing is flexed, the distal ex-

tremity of the antibrachium lies near the proximal end of the brachium. Along the middle part of the antibrachium its two bones curve from each other, the ulna being curved to a much greater extent than the radius. The ulna is some longer than the radius. When in the natural position, the proximal end of the ulna projects considerably beyond the proximal end of the radius, while the distal end of the radius projects slightly beyond the corresponding extremity of the ulna.

THE ULNA.

The upper extremity of the ulna is drawn into a short protuberance, the olecranon process. It will be convenient to consider the ulna as presenting two faces and as many edges. The faces will be distinguished as anterior and posterior; the edges as radial and external. The external edge, a prolongation of the proximal end of which forms the olecranon process, marks the greatest convexity of the bone longitudinally. The radial lies directly opposite the external edge, and marks the greatest concavity of the bone longitudinally. The radial edge leaves the proximal end of the ulna, where that bone articulates with the radius, and becomes less distinct as it approaches the distal end. The anterior face is slightly concave longitudinally; near the proximal end it is almost flat laterally, but near the distal end it is strongly convex laterally. The posterior face is slightly

FIG. 8.—BONES OF THE FOREARM



1. Ulna. 2. Radius.

convex longitudinally, and strongly convex laterally. Besides the olecranon process, already mentioned, the proximal end of the ulna bears, towards its anterior face, a semi-lunar depression which fits upon the ulnar tuberosity of the humerus, and towards its posterior face, a smaller facet which glides upon the radial tuberosity of the humerus, when the wing is strongly flexed. The eminence bordering the smaller facet is the most prominent part of the proximal end of the bone. Just on the border of these facets and where the radial edge first appears, is a small shallow facet in which the head of the radius lies. The distal end of the ulna presents, towards its anterior face, a rough protuberance which points upwards and terminates in two points; towards its posterior face, a thick rounded protuberance which bends slightly downwards and backwards. The depression between these two protuberances is concave laterally and convex vertically.

THE RADIUS.

The shaft of the radius is sub-cylindrical near the proximal end; but flattened toward the distal end. The proximal end is marked by a circular depression, which moves upon the radial tuberosity of the humerus when the wing is flexed. On the ulnar side, the border of this depression is flattened, so that the head of the radius lies upon the ulna and is securely attached to that bone. Toward the distal end, the radius is slightly curved, the anterior aspect being concave. The distal end is the widest part of the bone and lies on its edge in the median depression of the corresponding extremity of the ulna, and with its anterior face against

the posterior side of the upward-projecting protuberance of the ulna. This extremity of the radius projects a little beyond the ulna.

THE HAND.

In describing the hand of birds, Owen says: "The bones of the hand are developed in length, but contracted in breadth. The wedge-like adjustment of the free carpals is such as to restrict the movements of the hand upon the arm to abduction and adduction, or flexion in the ulno-radial plane, requisite for the outspreading and folding up of the wing. The hand of the bird moves thus in a state of pronation, without the power of rotation, or of proper flexion or extension, i. e. in the anco-palmar direction; so that the wing strikes firmly, and with the full force of the depressor muscles upon the air."

FIG. 9.—BONES OF FORE-ARM AND HAND. (AFTER HUXLEY.)

1. Ulna. 2. Radius. 3. Ulnar carpal. 4. Radial carpal. 5. Index finger. 6. Third metacarpal. 7. Digitus annularis. 8. First phalanx of middle finger. 9. Second phalanx of middle finger.

The large feathers which cover the hand, are called the "primaries;" those which belong to the fore-arm are called the "secondaries;" while those of the arm are called the "scapularies." The bunch of feathers attached to the index finger form the "spurious" or "bastard" wing. The office of prehension for which the complex hand of man is so well suited, is, in birds, filled by the beak. Consequently the capability of the great variety of motions

necessary to an organ of prehension, is tranferred from the hand to the neck. In birds of flight the length of the fore-arm and hand is greater than in *gallinaceous* birds.

CARPAL BONES.

The carpal bones are two in number and are designated by the names "radial" and "ulnar." The radial carpal presents three articular surfaces. The facet for the radius is deep; but does not extend across the full width of the bone. Just opposite this facet is another for articulation with the metacarpal. This one is beveled at the expense of the inner side of the bone. On the posterior border of the bone, there is a small facet which serves for articulation with the radial edge of the distal end of the ulna. The superior face of the bone is marked by a longitudinal groove. The remaining surface of the bone is somewhat irregular in order to better serve for muscular attachment. Since Coues' description of the second or ulnar carpal of the Colymbus Torquatus, suits equally well for the same bone in the fowl it is here copied in full. "The second smaller bone of the carpus, which represents the second row of carpal bones, is placed just in the bend of the joint on the ulnar side, wedged in between the ulna and metacarpus, with both of which it articulates. Its ulnar aspect presents a smooth, oval, somewhat depressed facet, which plays against the extremity of the large articulating surface of the ulna. Its metacarpal aspect presents a very deep horizontal notch or fissure, into which is received the inferior thin border of the metacarpal bone. In flexion and extension of the metacarpus, this small bone rides backwards and forwards along the edge of the

metacarpal bone, being, as it were, astride of the latter. The non-articular aspects of the bone are rough for the attachment of tendons." The radial carpal corresponds to the first row of carpals, or to the scaphoid, semilunar, and cuniform in the hand of man. The carpals of the hand of the goose differ but little, only in size, from those of the chicken. The size of the two carpals is about the same in the chicken; while the radial carpal is much the larger in some birds.

THE METACARPUS.

The metacarpus consists of three bones which are firmly grown together. The radial metacarpus is the smallest and appears as an enlargement or process, belonging to the proximal end of the large middle metacarpal. The proximal end of the radial metacarpal is prominently elevated and serves for muscular attachments; while its distal end lies close to the middle metacarpal, and supports the index finger. The middle metacarpal or the "medius," is the largest of the three. Its proximal end articulates with the two carpals; while its distal end supports the middle finger. The third metacarpal is bent so that while each of its extremities is anchylosed with the corresponding extremity of the "medius," the bodies of the two bones are separated by a space about one-fourth of an inch wide. The proximal end of the third metacarpal articulates with the ulnar carpal; while its distal end supports a digit which corresponds to the digitus annularis, or ring finger. In the hand of the goose, the third metacarpal is not bent so much as in the hand of the chicken; and consequently the space be-

tween the second and third metacarpal is not so wide in the hand of the goose as in that of the chicken.

THE PHALANGES.

The index finger consists of two phalanges. The proximal phalanx of this finger is from one-half to three-fourths of an inch in length, rough and trihedral. Its radial aspect is marked by a sharp, prominent ridge. This phalanx is movably articulated with the first or radial metacarpal bone. The second phalanx of this finger is only a small pointed spicula of bone, about one-fourth of an inch in length. Most of authors represent this finger as having but one phalanx; but if care be taken not to lose any of the parts in masceration, two phalanges will certainly be found in this finger both for the chicken and the goose. Some authors call this finger the pollex, or thumb; while others call it the index finger; but most authors agree in describing this as consisting of but one phalanx. A careful examination will show that there are two in some varieties of the domestic fowl, at least, if not in all.

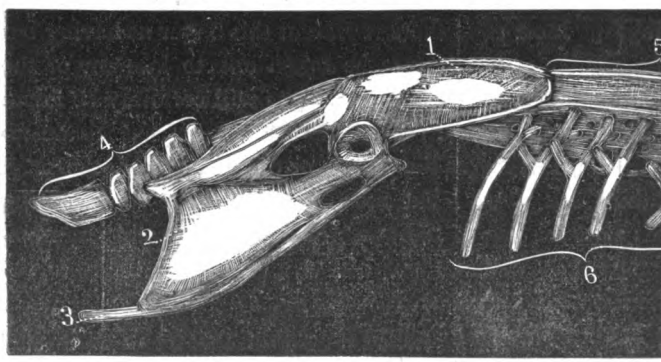
The middle phalanx also consists of two phalanges. The proximal phalanx of this finger is thick along its radial side; but much expanded and thin along the ulnar side. The lamelloid expansion of this phalanx is excavated for the attachment of the primaries. The second phalanx of this finger is trihedral and terminates in a point. Its radial side is thick; while a sharp, prominent ridge marks its ulnar aspect. According to Coues, this finger in the Colymbus Torquatus consists of three phalanges; the third phalanx being a very small, insignificant, acutely pointed spicula of

bone, scarcely a third of an inch long. The digitus annularis consists of one phalanx. It is about one-half an inch long, and lies along the border of the expansion of the first phalanx of the middle finger.

BONES OF THE PELVIS.

The pelvis consists of three bones, the ilium, ischium and pubis. These three bones are firmly united, forming a pair of strong, large irregular bones.

FIG. 10.—BONES OF THE PELVIS.



1. Ilium.
2. Ischium.
3. Pubis.
4. Caudal Vertebra.
5. Consolidated Dorsal Spine.
6. Ribs.

The ilium is remarkable for its length. Anteriorly it extends over the last dorsal, and posteriorly it terminates upon a line with the fifth coccygeal vertebra. Its superior edge with the exception of a short distance at its posterior extremity, is firmly united to the vertebral column. Anteriorly this edge is united to the spinous processes, which here are consolidated, and the transverse processes extend out-

ward against the slanting ilium. In this way a foramen is formed on each side of the consolidated spinous processes. The roof and external wall of this foramen is formed by the ilium. The floor is formed by the transverse, and the internal wall by the spinous processes. The inferior edge of ilium along its anterior part, is free, then forms a part of the the acetabulum, next forms the superior boundary of the sciatic foramen, and posterior to this, is united with the ischium. The superior face of the ilium in front of the acetabulum, slants forwards and downwards. This forms an extensive surface for the attachment of the glutæi and other muscles. The iliac border of the acetabulum is rough, and prominent, its most prominent point being next to the sciatic foramen. Here the border extends up so as to form a protuberance, which is grooved upon its acetabular side. This protuberance fits against the internal side of the great trochanter of the femur, has a rounded convex border, and is called the antitrochanter surface. Directly over this protuberance, the bone is slightly depressed, and above the depression is raised again. Over the sciatic foramen, the superior face of the ilium is broad and but slightly convex. Posteriorly it terminates in a point, which is directed upwards. Back of the sciatic foramen, there is a marked protuberance, which points out over the ischium. The internal or inferior face is even more irregular than the superior. Anteriorly it is rough and convex from side to side. But more posteriorly and in the region of the acetabulum and sciatic foramen, it is hollowed out deeply. This depression extends back as a pocket even beyond the last sacral vertebra.

The ischium is narrow and thick at its anterior end,

where it forms the back part of the acetabulum. Beyond this, it forms the inferior border of the sciatic foramen and still more posteriorly its internal or superior border is joined to the inferior or external border of the ilium. Its posterior border slopes downwards and backwards. Its inferior border is thick and passes from the acetabulum backwards to the posterior point of the bone. The shape of the ischium is triangular, narrow anteriorly, and widening posteriorly. Its external face is smooth, but has a slightly raised border. Its internal face has a ridge passing longitudinally and almost parallel with the inferior border.

The pubis is a small slender bone lying along the inferior border of the ischium, with which it is united by fibrous tissue. Anteriorly the pubis forms the lower part of the acetabulum where it is joined to both the ilium and ischium. From the acetabulum, it passes backward and touches the ischium again forming the foramen ovale. Beyond this, it has no osseous connection with the ischium, but passes beyond the posterior extremity of that bone, then turns upwards and more in towards the bone of the other side.

FEMUR.

The shaft of the femur is cylindrical, curved forwards strongly, outwards slightly, and presents the appearance of having been twisted. The extremities are well marked, presenting many characteristic features. Projecting from the upper extremity is a short protuberance, with its axis almost at right angles with that of the shaft. This protuberance bears the head, which is hemispherical and fits into the acetabulum. The head is more or less rough for

FIG. 11.—FEMUR, TIBIA AND FIBULA.

1. Femur. 2. Tibia 3. Fibula.

the insertion of the ligamentum terres which fastens the femur securely to the body. Below the head, the protuberance is slightly constricted, forming the neck. Opposite the head on the external side, the bone is rough, thick, extends upwards and slightly inwards, forming the great trochanter. The space between the head and trochanter is smooth, and forms a firm support for the body. The lower extremity of the femur has two prominent condyles, internal and external, and a deep median fossa. The fossa is concave laterally and convex longitudinally The internal condyle, the smaller of the two, presents a smooth convex border, narrower above, wider below. The external condyle extends further down than the internal. Posteriorly, the external condyle is divided by a slight depression. Of these two parts the internal is the larger, and belongs to the tibia, while the depression and outer part fit upon the head of the fibula.

The patella, which is a small irregular bone, lies in the intercondylar fossa. Its inferior surface is strongly convex. Each side of this convexity is a smooth face, which fits against and moves along the internal face of the corresponding condyle. The patella is bound by strong, wide ligaments, to the femur.

TIBIA.

This is the longest bone of the body. It is slightly curved, so that the two extremities and the middle point project farther forward than the intermediate points. The shaft is cylindrical near the middle point, but increases in its transverse diameter toward its extremities. The upper extremity is broad, presenting an extended surface for the femur to rest upon. It has two depressions, an internal and an external. The internal is shallow, regular, receives the inner condyle of the femur and is called the "entocondylar" surface. Posteriorly to the entocondylar surface, the bone is smooth and projects backwards over the shaft. The external or "ectocondylar" surface, which receives the external condyle of the femur is rough and slants outwards, being much deeper than the internal. The ridge dividing these two surfaces. is called the "intercondylar" convexity. Posterior to the ectocondylar surface, is a small hemispherical protuberance, to which the fibula is united by ligaments. Anterior to these articular surfaces, there is a crest which rises above them and is extended transversely. The posterior face of this crest is rough and conforms with the surfaces, already described, in general shape. The anterior face of the crest is marked by a thin, prominent, crooked ridge. This ridge forms the most prominent feature of the upper extremity of the bone, occupying its anterior aspect. The ridge presents two sides and an edge. The external or fibular side is smooth and concave in both directions; the internal side is smooth and convex. The edge is thin and convex. The ridge corresponds with the intercondylar convexity which lies on the posterior side of the crest and has already been

described. On the external, or fibular side of the bone, the crest projects out further than the main portion of the head and terminates in a thickened point. The lower extremity of the tibia bears two prominent, smooth condyles, with a deep median fossa. These condyles are developed from behind forwards, being more prominent anteriorly than posteriorly. On the anterior face of the bone, these condyles begin as ridges about an inch from the distal end of the bone; while on the posterior face, they do not extend up half so far. Anteriorly, the median groove is deep and is often crossed by ligaments which are found ossified in the old subject. The internal condyle is the more prominent of the two.

FIBULA.

The fibula is a small bone situated along the external side of the tibia, and attached to that bone. It becomes smaller from above downwards, terminating in a point about four-fifths the distance down the tibia. Its head is compressed laterally and points backwards, being convex along its longer axis. The internal or tibial side of the head is smooth and slightly concave, while the external is convex. It is attached to the tibia, for about one-third its length, this distance being well marked on both bones; being shown on the tibia by a ridge, which suddenly terminates at the point of severance.

TARSO-METATARSUS.

The upper extremity of this bone, like that of the tibia, has two articular surfaces, the "entocondylar" and the "ec-

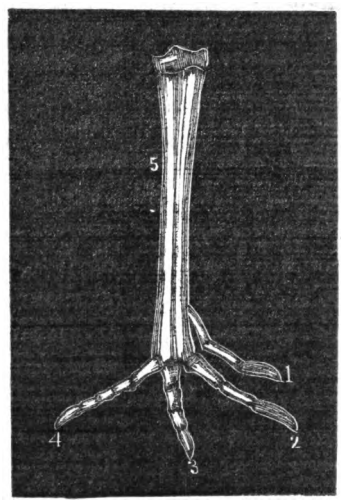
tocondylar." The entocondylar is the deeper, having a more prominent border than the other. The space between these surfaces is called the intercondylar space. From the interior part of this intercondylar space, rises a small protuberance, which acts as a brace while the bird is roosting. On the posterior aspect of the proximal end, there is a prominent elevation, which is subdivided by a shallow groove, and which is pierced by a canal. This protuberance, or these protuberances, is called "calcaneal," and the grooves serve for the passage of the tendons of some of the muscles. The anterior aspect of the bone towards the proximal end, bears a longitudinal depression. This depression is nearer the inner side, and is deepest directly under the head, and gradually becomes less distinct until it disappears near the "spur." The spur is a strong projection which points inwards, coming off from the tarso-metatarsus, down about two-thirds its length. Often there is a second rudimantary spur. The posterior aspect of the bone near the spur presents a slight, longitudinal grove, along which tendons pass. Below the "spur" the bone becomes thinner and wider, terminating in three condyles, separated from one another by two "fore-and-aft" grooves. These condyles serve for the attachment of the second, third, and fourth toes. The inner condyle, one for the second toe, is smooth, hemispherical in shape, and does not bear a groove. The middle condyle, the one for the third toe, is the longest of the three, and bears a median groove, concave laterally, convex longitudinally. The outer condyle, one for the fourth toe, is about equal to the internal in size, but it bears a groove similar to that on the middle condyle. The first toe is attached to the tarso-metatarsus by ligaments only. It

comes off a little above the level of the other three—between the "spur" and the second toe, but much nearer the toe, and projects backwards and inwards. Owen names the bone which has been here described as tarso-metatarsus as *metatarse*, but the name of tarso-metatarsus is the one most generally used.

THE TOES.

The toes are four in number. Three of these project forwards, while the other projects inwards towards the opposite leg, and slightly backwards. The first three may be known as the anterior, and the other as the posterior. The posterior one corresponds to the "hallux" or great toe. The others are, from the hallux outward, second, third and fourth. The fifth toe is entirely wanting. The third toe is the longest, and the first or "hallux" is the shortest. The second and fourth toes come off from the metatarsus on the same level, the third comes off lower than the second and fourth. The metatarsal of the first toe is separate from the tarso-metatarsal bone, and arises above the union of the three protuber-

FIG. 12.—THE FOOT.



1. Posterior toe.
2. Second toe.
3. Third toe.
4. Fourth toe.
5. Tarso-metatarsus.

ances, which mark the distal end of the tarso-metatarsus. The first toe has two phalanges; the second three; the third four; and the fourth five. The proximal end of the phalanges is called the *basis*, and the distal end the *capitulum*. The basis has a horizontal depression, or *fossa articularis transversa*. The superior border of this fossa is called the *tuberculum superius*, and the inferior border the *tuberculum inferius*. The capitulum consists of two lateral condyles and a median vertical groove or *sulcus longitudinalis*. The motion of the phalanges is limited to one direction. In the embryo, at first, the toes are all of the same length; but soon the anterior toe ceases to increase in length as the others do. The distal phalanx of each toe is pointed and curved to correspond with the claw. The body or middle part of the phalanges is smaller than the extremities. The inferior surface of the body is curved upwards, so that on this side, the bone is concave longitudinally. The upper and lateral aspects of the bone are smooth and evenly rounded.

THE RIBS.

In the domestic fowl there are seven pairs of ribs; in the duck there are nine pairs; and in the red-tailed hawk there are eight pairs. In birds in general, the number of pairs of ribs varies from six to twelve. Each true rib consists of three parts, the dorsal part, the sternal part, and the *hamulus costalis* or *processus uncinatus*. The false ribs may consist of one, or of two parts; but never of three. The false rib may be, and generally is, only the dorsal part, or the dorsal part with the processus uncinatus; while in some

cases the sternal part only will be found, and will constitute the false rib. In the fowl, there are two pairs of false, and five of true ribs. The false ribs are the first two pairs. The first pair generally consists of the dorsal part only; and the second pair consists of the dorsal part with a short process.

The three parts of the true rib are united with one another, with the vertebra and with the breast bone.

The dorsal part of the rib is wide and has sharp edges. Each rib unites with the vertebral column in two places. The two branches, at the proximal end of the ribs, are known as the *Capitulum* and the *Tuberculum*. The *Capitulum* articulates with the body of the vertebra; but not with two vertebræ, as is the case in man and other mammals. The *Tuberculum* articulates with the transverse process of the same vertebra, with which the *Capitulum* articulates. The space between the *Capitulum* and the transverse process, corresponds to the foramen which pierces the base of the transverse process in the cervical vertebræ. From the vertebral column, the anterior ribs, or the anterior dorsal ribs, extend downward and backward; while the posterior ones extend downwards and forward, to terminate against the extremities of the sternal ribs.

From the posterior edge of the lower third of the dorsal rib, a process, the *hamulus costalis*, is given off. It is thin and of nearly the same width as the rib. It passes upward and backward over the succeeding rib. This process is developed as a separate bone; but in the domestic fowl, and indeed in most of birds, soon becomes completely fused with the dorsal rib. In some rare instances, the union is not complete; but by means of ligaments. These process-

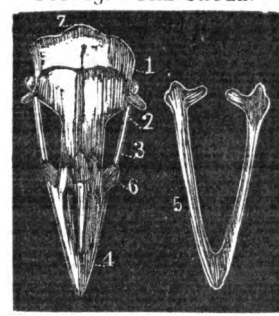
es give additional strength to the ribs, and according to Selenka, are very long and strong in birds of prey; but short and weak in the *natatores*. The sternal ribs are attached to the sternum at one extremity, and to the dorsal ribs at the other extremity. The sternal end is furnished with two tubercles, which fit into facets along the costal border of the sternum. This attachment is by means of a *ligamentum capsulare*. The superior extremity of the sternal rib is attached to the inferior extremity of the dorsal rib, by means of a ligament. Selenka gives the ligaments of the ribs as follows: "The principal ligaments are, a *ligamentum capsulare*, which binds the head of the rib to the body of the vertebra; the *lig. transversum externum*, between the tubercle of the rib and the transverse process; the *lig. triangulare*, which connects each *proc. uncinatus* with the posterior edge of the corresponding rib; and a *lig. capsulare* which binds the ends of the dorsal ribs to the sternal ribs. The sternal end of the sternal ribs is attached to the sternum by a *lig. capsulare.*" The dorsal part of the last pair of ribs is often united with the ilium, and the sternal part of the last two pairs is covered by the expanded extremity of the posterior costal process. The *processus uncinatus* is, of course, wanting in the last pair of ribs.

BONES OF THE HEAD.

There are twenty-nine bones belonging to the head. This number does not include the hyoid bone, which may be considered as belonging to this region. Of these twenty-nine bones, five are single, and twenty four are in pairs.

The single bones are, the occipital, basisphenoid, orbitosphenoid, vomer and inferior maxillary. The bones in pairs are, the parietals, temporals, alisphenoids, tympanics, pterygoids, frontals, nasals, premaxillaries, maxillaries, lachrymals, malars, and palatines. The bones of the head may be divided into two classes, those of the skull and those of the face. The bones of the skull are fifteen in number, three single, and twelve in pairs. The single bones of the skull are, the occipital, the basisphenoid, and orbito-sphenoid. The bones of the skull, in pairs, are parietals, temporals, frontals, alisphenoids, tympanics, and pterygoids. The bones of the face are fourteen in number, two single and twelve in pairs. The single bones of the face are the vomer and inferior maxillary. The bones of the face in pairs are, the malars, palatines, premaxillaries, nasals, maxillaries and lachrymals. Since the bones of the skull are so closely united, it will be well to examine it first as a whole, and to notice some of the most prominent features, by means of which the position of some of the bones can be determined. The posterior aspect of the skull is semi-circular in shape, with the prominent arched occipital ridge for the border. This aspect is occupied by the occipital bone. It is pierced by a large opening, the foramen magnum. As will be described more fully hereafter, the occipital is developed from four bones, the basi-occipital, two exoccipitals, and the supraoccipital. The

FIG. 13.—THE SKULL.



1. Temporal.
2. Frontal.
3. Molar.
4. Pre. Maxilliary.
5. Sup. maxilary.
6. Lachrymal.
7. Occipital.

supraoccipital forms the superior, the exoccipital the lateral, and the basioccipital the inferior margin of the foramen magnum. The condyle on the inferior border of the foramen magnum is known as the occipital condyle, and serves to articulate the skull to the vertebral column. It fits into the depression in the body or anterior arch of the atlas. The *superior aspect* of the head is strongly convex, both longitudinally and laterally. It is bounded posteriorly by the occipital ridge, and anteriorly it terminates in a point at the distal extremity of the beak. Just in front of the occipital ridge, lie the parietal bones, which unite with each other on the median line, and extend down on each side, resting on the temporal bones. The position of the temporal may be known by its zygomatic process, which projects forwards and downwards, and generally unites with the distal end of the post-orbital process, from the alisphenoid. The parietals are about one-fourth of an inch wide. In front of the parietals, are the frontals, which extend forward between the orbits and terminate about one-fourth of an inch behind the posterior border of the opening for the nares. At each external anterior corner of the frontals, there is anchylosed a small bone, which projects outwards, forming an antorbital process, and which sends from the anterior part of its inferior surface, a process down towards the malar. This small bone corresponds to the lachrymal bone in the human skull. Anteriorly to the frontals, the nasal branches of the premaxillary extend forwards, forming the superior border of the osseous boundary for the nares; while the nasals bifurcate, and the descending branch forms the posterior border of the same opening. The *lateral aspect* of the head is mostly taken up by the orbital space. The orbito-

sphenoid forms the septum between the orbits. The frontals form the roof of the orbits; the alisphenoids separate the orbits from the cranial cavity; the long slendar malar forms the very defective floor of the orbit; the descending process of the lachrymal partially separates the orbital space from the antorbital vacuity, and the body of the lachrymal forms the antorbital process.

The *inferior aspect* of the head is occupied posteriorly by the basisphenoid, which forms the floor of the cranial cavity. The tympanic bone lies just in front of the depression for the ear. It articulates with the inferior edge of the temporal immediately under the base of the zyogmatic process, and extends forwards and downwards. It sends a process, the orbital process, up into the orbit, and to its distal end are articulated the malar and the inferior maxillary. The pterygoids articulate with the tympanics, under the orbital process, then extend forwards and inwards to unite with the orbitosphenoid and the posterior extremity of the palatine. The malars are the long, slender bones, which extend from the mandibular extremity of the tympanic forwards, to the superior maxilliary. The palatines lie inside the malars, and have the same general direction. The vomer is a small single bone which lies between the two palatines. Posteriorly it comes off from the anterior border of the obitosphenoid, and anteriorly, it terminates against the palatal plate. The mandibular branches of the premaxillary form the principal part of the inferior border of the opening of the nares; while the body of the premaxillary, or the combined bodies of the two premaxillaries, forms the beak.

The bones of the head are generally so closely united, that their limits cannot be easily determined. For this

reason, the skull of a very young bird, or of the embryo, should be examined with reference to the shape and limits of each bone. The descriptions which are given here, were made from three skulls of young chickens. Two of these belong to the very valuable Sager collection in the Museum of the University of Michigan.

OCCIPITAL BONE.

This bone represents the first cranial vertebra. It encloses the foramen magnum, and furnishes the occipital condyle, by means of which the head is articulated to the neck. The occipital consists of four bones, which are separate in the young, but are generally closely united in the adult skull. These bones are the basioccipital, two exoccipitals, and the supraoccipital.

The basioccipital is a small triangular bone. It lies beneath the foramen magnum, and furnishes the greater part of the occipital condyle. Inferiorly it rests upon the basisphenoid, laterally it is united with the exoccipitals, and superiorly it terminates in the middle part of the occipital condyle, Its outer surface is raised along the base, and slants upwards, forming a depression, fossa subcondyloidea, just under the condyle. Its inferior border has a concavity, which is matched by a corresponding convexity in the border of the basisphenoid. The condyle is semilunar in shape, and is marked by a median notch which slants towards the foramen.

The exoccipitals form the lateral margins of the foramen magnum. They are of very irregular shape. The upper

part of the external surface is elevated and furnishes a projection which slants downwards and outwards. The lower portion of the external surface slants towards the basioccipital, and is pierced by four foramina. Through two of these foramina, pass the hypoglossus and par vagum, and accessorius; through the other two, blood vessels pass.

The supraoccipital forms an arch which extends from the exoccipital on one side to the corresponding bone on the other. It forms the upper margin of the foramen magnum and completes the ring. Anteriorly it unites with the parietal, and temporal bones. Its outer surface is strongly convex from side to side; its inner surface being deeply concave in the same direction. It covers the cerebellum. In the skull of the owl the occipital bone is not so thick and strong as the same bone in the chicken, nor as the parietals and frontals in the owl. The median ridge of the supraoccipital, directly over the foramen magnum, varies much in size and form in different species of birds. In the skulls of the hawk and owl, this ridge is short and large; while in the skull of the goose it is long and forms a sharper ridge. The position of the supraoccipital is more nearly perpendicular in the skull of the goose, than in the skull of either the hawk or the owl. On each side of the base of this ridge in the skull of the goose, there is a large foramen, which is very small or wholly absent in the skull of the chicken. In the skull of the hawk the exoccipitals are full and prominent, and the fossa subcondyloidea is deep; while the condyle is not notched. The occipital condyle in the skull of the goose projects prominently, is not notched, and its superior surface is slightly concave from side to side.

PARIETAL BONES.

These bones are never very large. They are united with the supraoccipital posteriorly and with the frontals anteriorly. Each rests upon the temporal, arches over and meets its fellow from the other side of the head. Each bone is of an irregular quadrilateral shape, presenting two surfaces and four borders. The external surface is smooth and convex; the internal is irregular. At the posterior, superior angle, the internal surface slants upwards and backwards, assisting the supraoccipital in the formation of the concavity for the cerebellum. Along the anterior border, the internal surface slants forward, assisting the frontals in the formation of the concavity for the cerebrum. The superior border, the shortest of the three, is dentated to unite with its fellow, forming the sagittal suture. The anterior border unites with the frontal, forming the suture known in human anatomy as the coronal suture. The inferior border is thick, beveled at the expense of the outer surface, and unites with the temporal. The posterior border unites with the supraoccipital. In most adult skulls, the parietals are so closely united with the adjoining bones, that its shape and limits cannot be seen. Generally a slight transverse depression is visible along and just anterior to the coronal suture. The direction and approximate position of the line of union with the supraoccipital may be known by the fact that it lies along and just in front of the prominent ridge which passes down each side of the supraoccipital. A small inter-parietal bone will, in some rare instances, be found. It lies at the posterior, superior angle of each parietal, and between those bones and the supraoccipital.

TEMPORAL BONES.

The temporal bones lie. one on each side, at the base of of the parietal and just above the depression for the ear. In the adult skull, the length is about two and one-half times the breadth. It presents two surfaces and three borders. The external surface is smooth and has a slight depression along the direction of the length of the skull. The internal surface is rough, uneven, and forms a part of the wall of the cranial cavity. The superior edge is bordered by the parietal and the frontal. This edge is nearly straight along the line of union with the parietal; but from the coronal suture it becomes thin and passes forward and downward to the inferior edge. The inferior edge is thick and rough. Posteriorly it forms a part of the upper border of the depression for the ear. Anteriorly it unites with the alisphenoid. Along the inferior edge, and over the depression for the ear, there is a small deep facet for articulation witn the tympanic, which forms a movable articulation at this place. Just anterior to this facet, there is a projection upon the inner surfaces of which the short process of the the alisphenoid fits. Still more anteriorly there is a second eminence bearing a groove, which passes inwards and backwards. This groove fits upon the base of the large process of the alisphenoid. In the skull of the owl, the temporal bone projects forwards and upwards, forming a thin, wide process, which stands out prominently over the temporal extremity of the tympanic bone.

The process, which is given off from the inferior edge of the temporal, just over the facet for the tympanic, is the zygomatic process. It projects forwards and downwards and

most generally unites with the distal extremity of the post-orbital process, which is given off from the alisphenoid. The zygomatic process is the first lateral process from the skull, from behind forwards. It is usually quite thin and sends on a projection beyond its point of union with the post-orbital process. This projection is flexible and terminates in a point. In the skull of the owl, the projection which has already been described as standing out prominently over the temporal extremity of the tympanic, corresponds to the zygomatic process. In this case, it does not unite with the post-orbital process.

ALISPHENOID.

This bone lies directly in front of the depression for the ear, and its position may be at once known by the process which projects so prominently from that part of the skull. It is united below and behind with the basisphenoid, above with the temporal and frontal and before with the orbitosphenoid. The bone is of an irregular shape and consists of a body and a process. The internal surface of the body is smooth and deeply concave. The edge of the bone in front and above the concavity, is thick, flat, and smooth. Often there is a vertical opening through the floor of the concavity. The external surface is uneven and convex. Along the line of union with the basisphenoid and just in front of and below the depression for the ear, there are two (sometimes only one), foramina. Also along the line of union with the temporal and just posterior to the prominent process, there is a foramen. The process slopes outwards and downwards, presenting an anterior and a posterior face;

and an inferior and superior edge. The superior edge is thick and slants downwards and outwards. The inferior edge is generally concave; though all the parts of this process vary in direction and extent of development. In the skull of the owl, the process of the alisphenoid does not project outwards, but downwards and forwards. It is thin and about one-half an inch wide at the base, but becomes narrower and terminates in a point. Its anterior face is concave both laterally and longitudinally; while its posterior face is convex in both these directions. It forms a small part of the floor of the orbit. In the skull of the hawk, the process of the alisphenoid projects outwards, downwards and slightly forwards, terminating in a point over the mandibulax extremity of the tympanic bone to which it is united by a cartilage. In the goose, this process is very thick, strong and blunt. It projects forwards and slightly outwards. In the scansores, as the woodpecker, this process is very short and has the same general shape and direction as in the rasores. The body of the alisphenoid is generally very closely united with the contiguous bones. The process is called, from its position, the "post-orbital" process.

BASISPHENOID.

This is the large, irregular bone which lies at the base of the skull. The basioccipital and exoccipitals rest upon the posterior border of the basisphenoid. Laterally the basisphenoid forms the lower part of the depression, for the ear, and anterior to this depression, its border slopes downward and inward, supporting the alisphenoid. From the middle point of its anterior border, the basisphenoid sends forward

a process, the *Rostrum sphenoides*, which supports the vertical orbitosphenoid and gives attachment to the pterygoids and the palatines. The inferior face of the basisphenoid is divided into halves by a ridge, which lies in an antero-posterior direction. Each half is smooth, strongly convex in the direction of the length of the skull, and slightly concave in the direction of the width of the skull. The external, lateral, borders of these halves form the lower border of the depression for the ear. Posteriorly these borders pass upwards and backwards, forming processes, which approach and often touch the processes of the exoccipitals; thus forming a notch or a foramen, which passes from behind into the depression for the ear. Anteriorly these halves are bordered by slight eminences, which pass from the anterior, inferior angle of the depression for the ear to the base of the Rostrum Sphenoides. Directly under the base of the Rostrum Sphenoides, there is a horizontal, triangular depression, which has for its floor a prolongation of the antero-posterior ridge which has already been described as dividing the inferior face into halves. On each side of the base of the Rostrum Sphenoides, there is a horizontal fissure. Near its base, the Rostrum Sphenoides bears, on each side, an articular surface which looks downwards and outwards, and serves for the articulation with the pterygoids. The upper or internal surface of the basisphenoid is irregular. Posteriorly it slants backwards; anteriorly and at the base of the Rostrum Sphenoides, there is a deep circular depression. This, like the other bones of the skull, is so closely united to the adjoining bones in the adult skull, that it can be studied satisfactorily only in the young bird.

In the skull of the hawk, the inferior face of the basisphe-

noid is divided into halves by a median, antero-posterior ridge, as in the chicken; but in the skull of the owl, this surface is divided into halves by a depression, instead of a ridge and the two halves instead of being depressed are elevated. Indeed, in the skulls of some varieties of the domestic fowl, the inferior surface of the basisphenoid is not divided into halves by a median ridge. In the goose, the median ridge is short; but generally very prominent. In the owl, the lateral processes from the posterior part of the inferior face, unite with the processes from the exoccipitals and form a foramen which passes from below up into the depression for the ear. In the owl, this union is so complete as to leave but a very small, or no foramen.

TYMPANIC.

The tympanic unites the lower jaw with the skull. It presents a temporal and a mandibular extremity and an intermediate body, from which the orbital process is given off. The temporal end terminates in a small, smooth, sessile head, which fits into a depression in the inferior border of the temporal bone at the anterior, superior angle of the depression for the ear. The external face and posterior border are smooth and concave; the anterior border is convex. From near the middle point of the anterior border, the orbital process extends, first upwards and inwards; then inwards and slightly backwards. The pterygoid articulates with the tympanic directly under the base of the orbital process. The body is much larger below than above the orbital process. The mandibular end presents two articular surfaces separated by a shallow depression. The external articular

surface, the larger of the two, is convex and projects outwards and backwards. The malar joins the tympanic upon the outer side of the projection. There is a great difference of opinion among comparative anatomists as to the name, which should be given this bone. It has been described as the homologue of the ramus ascendens of the inferior maxillary: as the os sqamosum; as the styloid process; and Huxley, Selenka, Parker and others consider it as the homologue of the quadrate bone in fishes, or of the incus in mammalia, and consequently they name it "os quadratum." It has also been called "os pedicellatum," and has been described under this name by Coues, in his admirable memoir on the Osteology of the Colymbus Torquatus. It has been described as the "tympanic" by Cuvier, Meckel, Wagner, Owen, and many others, who regard it as the homologue of the tympanic in the human skull. In the skull of the hawk, the tympanic is quite large and strong, and the orbital process is triangular, and wide and thin at and near the base. Also the depression at the mandibular extremity for the reception of the inferior maxillary, is large and deep. In the owl, this bone, like many others in the same skull, is of a cancellous structure, and not so dense as in many other birds.

PALATINE.

The palatines are two small, long bones, which are articulated posteriorly with the orbito-sphenoid and the pterygoids, and anteriorly with the maxillaries. Where they unite with the orbitosphenoid, they are expanded and thin. The two palatines do not touch each other along any part of their

course. At the posterior extremity, they are separated by the orbitosphenoid; just anterior to this, they diverge; then pass on nearly parallel to join the maxillaries. They are attached along the under surface of the maxillaries and can be distinguished by the ridge along that surface as far forward as the premaxillary. Each is curved slightly outwards and upwards. The palatines of the hawk are very broad and strong. The superior surface is smooth and slants from the orbitosphenoid outwards. The inferior surface has a sharp, prominent ridge along the posterior part of its inner edge. This ridge becomes less prominent as it extends forwards and soon entirely disappears. Anteriorly, the palatines, in the skull of both hawk and owl, is united with a porous, somewhat convoluted bone, which corresponds to the turbinated bones in the human skull. The palatines of the owl are more curved than those of the hawk or the domestic fowl. The palatines of the goose are strong and appear as though they had been twisted. Their anteior halves diverge more than in the other skulls described.

PTERYGOID.

The pterygoids are short, strong bones which pass from the tympanic on each side, forwards and inwards. The outer end of the pterygoid articulates with the tympanic under the base of the orbital process. This extremity is much expanded and makes a strong articulation with the tympanic. The inner end articulates with the Rostrum Sphenoides and the posterior end of the palatine. This extremity also is much expanded. It overlaps the posterior end of the pala-

tine. The body of the bone presents the appearance of having been twisted upon itself. The pterygoids act as braces to prevent the tympanic and its attached bones from being forced inwards. In some birds, there is an osseous connection between the pterygoid and the anterior edge of the orbito-sphenoid. In other birds, as in the owl, this connection is an articulation. About half or two-thirds the distance from the outer extremity of the bone to the point of its articulation with the obitosphenoid and palatine, a small process is given off from its posterior edge, and this process meets with a corresponding one from the anterior edge of the basisphenoid. The extremities of these processes are beveled so that one glides upon the other and a moveable articulation is thus secured. In the skull of the hawk, there is a ligamentous connection between the two bones at this point; while in the chicken, there is no such connecfion, whatever. In the chicken, the tympanic extremity of the pterygoid assists in the formation of the depression for union with the inferior maxillary.

ORBITOSPHENOID.

The orbitosphenoid or ethmoid, is a thin vertical bone which forms a partial septum between the orbits. Its inferior edge rests upon and is united with the Rostrum Sphenoides; its superior edge is anchylosed with the inferior surfaces of the frontals. The superior edge is much expanded anteriorly and fills the angle formed by the divergence of the anterior extremities of the frontals. This expansion appears upon the external surface of the skull as a kite-shaped bone, widest anteriorly, then becoming narrower, and final-

ly disappearing at the point of divergence of the frontals. This kite-shaped face is bounded posteriorly by the frontals, laterally by the frontals and the nasals, and anteriorly by the posterior extremities of the nasal branches of the premaxillaries. The inferior or internal surface of the expanded part is divided into halves by union along its median line with the vertical part; and each of these halves is divided into two unequal parts by a ridge which passes from the outer corner of the expanded part, backwards and inwards to the base of the vertical part. The posterior edge is united with the alisphenoid and forms the anterior border of the large circular interorbital foramen. This foramen blends with the foramen *lacerum anterius*, which is bordered on each side by the edges of the alisphenoids and through which orbital portions of the fifth nerve pass. The anterior border is slightly concave, extends forwards and upwards, and is beveled on each side so as to form a thin, sharp ridge. The sides of the orbitosphenoid are smooth and raised around the borders. This bone is described under the name of presphenoid by some authors.

About half way up the anterior border of the orbitosphenoid, a small, thin projection stands out on each side. In the skulls of the hawk and owl, these lateral projections from the anterior border are large, and project forwards and downwards. There is a groove more or less marked, along the superior border of the orbitosphenoid. This groove serves for the passage of the olfactory nerve, which passes out from the cranial cavity at the posterior, superior angle of the orbitosphenoid. In the skull of the hawk, this groove pierces the base of the external lateral wings, which have been described as given off from the anterior border of the

orbitosphenoid. This bone is thin, but compact, and has not the spongy structure possessed by the ethmoid of the human skull.

FRONTALS.

These bones form the prominence of the forehead and the roof of the orbits. The suture between the two frontals is on a line with and is a continuation, in an anterior direction, of the suture between the two parietals. This line of union between the two frontals is, in some skulls, marked along its entire extent, by a slight depression; in others, all traces of a suture are obliterated; while in a third class of skulls, there is a rough ridge along the line of union. The anterior extremity of each frontal slants outward and terminates in a point; or, considering the two bones as one, the anterior extremity is deeply notched. This notch is filled by the expansion of the superior edge of the orbitosphenoid. The two lateral projections of the anterior extremity, are united with the nasal. The fronto-maxillary articulation does not allow so much movement as in the goose and many other birds. The lateral margin of the frontal is deeply concave forming the superior margin of the orbit. The posterior border lies across the roof of the cranium, and is anchylosed with the parietals. The frontal is united for a short distance at its external, posterior angle with the temporal. The external surface of the frontals is subject to considerable variation. Anteriorly, it is generally concave from side to side, or the surface of each frontal slants towards the other. The margin of the orbit is raised, forming the superciliary ridge. Just above the ridge, and separating it from the frontal emi-

nence, is a semilunar depression, which is parallel with the concavity of the superior margin of the orbit. Along the bottom of this depression are numerous foramina. In some skulls, this depression is entirely wanting. Posteriorly, the external surface is more or less elevated, forming the frontal eminence. Posteriorly, the internal surface assists in forming the roof and walls of the cranial cavity; while a plate of bone projecting from the orbital margin, horizontally inwards, assists in forming the floor of the same cavity. The inferior surface of this horizontal plate forms the roof of the orbit, and its posterior border unites with the alisphenoid. In the skull of the owl, the frontal eminence is large and prominent; while the arch from before backwards, is high. In the skull of the goose, the frontal eminence is not prominent, and the superciliary ridges are not well defined.

NASAL.

The nasal is united above, with the anterior extremity of the frontal and the posterior part of the nasal branch of the premaxillary; and below with the superior maxillary. It overlaps the long, pointed, anterior extremity of the frontal. Then extending forwards, divides into two processes. The upper and smaller one of these processes extends along, and is closely united with, the external edge of the nasal branch of the premaxillary, for about one-half the distance down the superior border of the aperture for the external nares. Here it terminates in a point. The other process passes forwards and downwards, and anchyloses with the superior maxillary, where that bone unites with the malar.

This process forms the posterior border of the osseous boundary of the large aperture for the external nares, separating that aperture from the antorbital vacuity; and it also forms the lateral osseous boundary of the nasal passages. The two nasal bones are not united in any part. At the upper extremity they are separated by the nasal branches of the premaxillary. The widest point of the nasal is near the point, where it separates into the two proceses. Here the external surface is concave from side to side, and inclines forwards and downwards. This bone is very strong and thick in the goose, where the articulation with the frontal allows considerable freedom of motion. In the skull of the hawk, the antorbital vacuity is triangular in shape, and bounded anteriorly by the descending ramus of the nasal, which separates the vacuity from the external aperture for the nares. Posteriorly, the antorbital vacuity is bounded by the descending process of the lachrymal bone, which separates the vacuity from the orbit. In the skull of the owl, the antorbital vacuity is almost entirely filled with the cancellated convolutions of the turbinated bone, in the same skull, the descending branch of the nasal is wide, thin and extends further forward than in the skull of the chicken. In some skulls, the descending branch of the nasal becomes very small and slender as it approaches the point of union with the superior maxilliary. The descending branch of the nasal is called by some authors the *processus maxillaris;* while the branch which extends forwards is called the *processus frontalis.* The nasal is united with the frontal, orbitosphenoid, maxillary, premaxillary, and lachrymal. The union with the frontal, orbitosphenoid and lachrymal may be a movable articulation, as in the goose.

PREMAXILLARY.

This bone is one of the largest and most important of the bones of the face. It terminates the head anteriorly and forms the osseous portion of the bill. Distally it terminates in a point, which projects forwards and downwards. From the distal extremity back to the opening of the nares, the bone is single, and its upper surface is strongly convex, while its inferior surface is concave, forming the anterior part of the palate. Then the bone separates into three processes, a medial, nasal process, and two maxillary or mandibular processes. The nasal process really consists of two processes which lie side by side. The line of union is shown by a small median groove. This process, or these processes, extend backwards and upwards, forming the superior border of the osseous boundary for the nares. Posteriorly the nasal branches of the premaxillary are anchylosed with the nasals, and united with the expanded part. of the superior edge of the orbitosphenoid. The maxillary or mandibular processes diverge, pass backwards, and anchylose with the superior maxillary. These processes form the inferior border of the aperture for the nares. This aperture is of an oval shape, being larger posteriorly than anteriorly. The divergence of the mandibular processes, forms a narrow longitudinal opening about one-eighth of an inch broad. This opening is covered by the lining of the palate. The premaxillary is subject to great variation in different species of birds. In the goose it is very large, strong and wide. The median groove along the nasal process shows that the premaxillary really consists of two bones.

In the goose the part of the premaxillary anterior to the

opening for the nares, is broad and strongly convex on its superior aspect. It is from one-half to three-fourths of an inch from the distal extremity back to the opening for the nares. The space between the two mandibular processes is entirely filled with the palatal plate, which is formed by lateral projections from these processes. The palatal plate is deeply concave from side to side. It bears a longitudinal median groove, which is large and deep. On each side of this median groove, there are quite a number of small grooves, which branch as they pass forward. The premaxillary in birds of prey is generally protected by a thick, hard covering, which projects down in front and laterally below the border of the bone.

Coues in describing this bone, which he calls the intermaxillary, says: "This is by far the most important, as it is the largest and most conspicuous bone of the face; its various modifications in the different families and orders of birds affording much the same data for zoölogical classification as do the teeth of mammalia." The shape of the premaxillary corresponds, of course, with the shape of the beak; or, more correctly, the form of the bone determines the shape of the beak. Consequently in the skulls of the hawk and owl, the distal end of the bone is hooked or curved. In the goose the nasal bones, and the nasal branches of the premaxillary, form a movable articulation with the anterior extremity of the frontal. By this means the upper jaw can be moved freely, at will.

In the goose the opening for the nares is about three-fourths of an inch long. It is broadest at the middle point and grows smaller towards each extremity. The vomer forms a partial septum between the two sides. In the skull

of the hawk, the opening is short and is widest at its anterior extremity. There is a complete septum between the two sides. In the owl, the opening is not as deep as in the goose and hawk. It is broadest near the middle, and there is a complete septum between the two sides, as in the hawk. In birds with short beaks, the nasal branches of the premaxillary are generally more prominently arched thanin those with long beaks. In the hawk there is a deep semi-circular depression where the posterior extremities of the nasal branches unite with the frontals.

MALARS.

The malars are the long, slender bones which form the lateral boundaries of the inferior aspect of the skull. They are about one and a quarter inches in length, and extend from the superior maxillary back to the outer edge of the mandibular extremity of the tympanic. The anterior extremity of the malar is united with both the superior maxillary and the nasal, at the point where the lower process of the nasal joins the maxillary. From its anterior extremity, the bone passes backward and outwards to the tympanic. The malar proper extends only about three fourths this distance. Here it unites with a similar, but shorter bone from the tympanic. These bones soon become united in the young skull; but the point of fusion can always be detected even in old skulls by a rough place, due to the blending of the bones. In some instances the malar unites with the descending branch of the nasal above the point of union of the nasal with the maxillary. In this case the

malar has no connection whatever with the maxillary. The office of the malar is to transmit the motions of the tympanic bone to the maxillary. In the skull of the hawk the posterior extremity of the malar is attached to the postorbital process by a strong ligament which is about one-fourth of an inch long. In the same skull, a wide process extends from the anterior extremity of the malar inwards, and is fused with the turbinated bone. Also tthe anterior extremity of the malar in the skull of the owl, is united with the turbinated bone. But in the latter case, the union is direct and not by means of a process as in the former.

SUPERIOR MAXILLARY.

In the adult skull this bone is so closely united with the contiguous bones that its limits cannot be defined. Anteriorly it insensibly blends with the posterior extremity of the mandibular process of the premaxillary. Posteriorly it unites with the malar, palatine, and inferior extremity of the nasal. Indeed the superior maxillary is only an osseous connection between these bones. From the internal edge of the maxillary, a thin, wide process extends inwards, approaching a corresponding process from the other side. This process corresponds to the palatal process. In birds, the maxillary is a subordinate bone, and the important part which it fills in mammals is principally taken up by the premaxillary. In the skull of the goose, the maxillaries are larger, but their limits no better defined than in the chicken. Since this bone is so completely and closely united with the contiguous bones, it can have no motion in which they do not participate.

LACHRYMAL.

To the anterior outer corner of each frontal, and to the adjoining upper part of the posterior border of each nasal is anchylosed a small bone known as the lachrymal. This consists of a body and a process. The body projects outwards and upwards, over the anterior part of the orbit, and from its position may be called the supraorbital part of the lachrymal bone. The body is a thin plate about one-eighth of an inch wide, or from the point of union of the frontal with the nasal outwards, and about one-fourth of an inch in length, or from the orbit forwards. Its superior face together with the contiguous surface of the nasal and frontal is convex; while its internal face, together with that of the nassal and frontal is concave. From the anterior part of the internal face of the body, a process extends first downwards and inwards, towards the corresponding palatine, and then downwards and outwards, approaching but not uniting with the malar. This process divides the orbital from the antorbital vacuity. It also assists the descending ramus of the nasal in forming the very defective osseous lateral boundary of the nasal passages. In the skull of the hawk the body of the lachrymal bone is quite large, extending outwards and upwards, over the orbit and articulating with a "similar supraorbital derm-bone;" while the process from the anterior part of the under face of the body is large, strong, extends down to, and unites with the malar.

In the skull of the short-eared owl, (*Brachyotus Cassinii*), the process of the lachrymal bone, is very large, cancellous, and unites with the malar, leaving but a very small antorbital vacuity. In the skull of the red-bellied wood-

pecker, (*Centurus Carolinus*), the process is wide, unites with the malar and forms a triangular antorbital vacuity. In the skull of the adult woodpecker, the body of the lachrymal is so firmly or completely united with the frontal, that its limits cannot be defined. The union of the lachrymal with the frontal and nasal in the skull of the chicken is not very close, and consequently the lachrymal is often lost in masceration, unless due care be taken.

THE VOMER.

The vomer is a small single bone, which extends forwards from the anterior inferior angle of the orbitosphenoid. It lies between the two palatines, and is connected with those bones, at the point where all three unite with the orbitosphenoid. Its anterior extremity lies free between the mandibular branches of the premaxillary. The vomer in the skull of the goose is thin and wide, but not strong. In the skull of the hawk the vomer is quite strong, and its posterior extremity seems to be closely united with the corresponding extremities of the two palatines, while its anterior extremity seems to be united with a turbinated bone. This bone also is often lost in preparing the skull.

INFERIOR MAXILLARY.

The inferior maxillary or lower jaw bone consists of a body and two rami. The body forms the anterior extremity of the bone, is triangular in shape, pointed anteriorly, and about one-quarter of an inch long. The inferior sur-

face of the body is strongly convex from side to side; while the superior surface is deeply concavein the same direction. The rami, one from each posterior corner of the body, diverge, pass at first backwards and upwards, and then backwards. Posteriorly each ramus terminates in two processes, an inner and a posterior process. The inner process projects upward and inwards towards its fellow from the other ramus. Its termination is thick and rough. The posterior process extends backwards and upwards, then slightly forwards so as to form a hook. Just anterior to the base of the anterior process and at the external side of the the base of the inner process, there is a long, lateral concave facet which fits upon the mandibular extremity of the tympanic. The inner process corresponds to the coronoid process, of the inferior maxillary of man; and the posterior process corresponds to the articular condyle, in position at least. The depression between these two processes in the inferior maxillary of man, is called the sigmoid notch. The superior edge of each ramus is convex; while the inferior edge is concave. The posterior part of the external face is somewhat rough, for muscular attachment. There is considerable variation in the extent of curvature, the size and strength of the rami of this bone in different species of birds.

MYOLOGY.

THE MUSCLES.

THE MUSCULAR SYSTEM.

Of the muscular system of birds in general, Owen says: "The muscular system of birds is remarkable for the distinctness and density of the carneous fibres, their deep, red color, and their marked separation from the tendons, which are of a brilliant, shining color, and have a peculiar tendency to ossification. This high degree of development results from the rapid circulation of very warm blood, which is highly oxygenated in consequence of the activity and extent of the respiratory functions. The energy of the muscular contractions, in this class is in the ratio of the activity of the vital functions, but its permanent irritability is proportionally low, as Carus has justly observed."

The tendons are especially remarkable for the degree of ossification. In regard to this fact the words of Chaveau are here quoted: "The tendons in birds present in the inferior limbs and at the extremity of the wings an amount of ossification more or less extensive along their course. This transformation of the fibrous tissue of the

muscles is not the effect of senility, for it is noticed in very young animals."

"The tendons in losing the greater part of their elasticity, doubtless gain in tenacity; and this allows them to transmit to the bony levers, the muscular efforts in a more integral manner."

"It is also observed that the partial ossification of the tendons does not exclusively belong to the limbs; for it is not rare to meet with this change in other regions, as in the neck of wading birds. In the museum of the Veterinary Schools at Lyons is the skeleton of a heron which shows this peculiarity in the highest degree; the cervical vertebræ are roughened by a multitude of filiform stylets, all directed backwards, and which have originated from the ossification of the tendinous fibrillæ annexed to the muscles of the cervical region."

From disuse many of the muscles of the domestic fowl are but feebly developed. The wings are used but little, and for this reason the muscles of the wings are not so well developed as those of the wings of the hawk or other birds of flight. All the muscles which will be described in the succeeding pages, are sufficiently developed for the purpose of study, in the domestic fowl; but they can be studied equally as well, and some of them much better, in large birds of flight. The muscles of the hawk are very well developed, and are suitable for study. It is well to dissect one or more subjects from each of the orders of birds and compare them. The muscles are given in groups. This division into groups being made upon their occupying the same or different regions; muscles which act in opposite directions may be found in the same group. This plan has

been followed because it has been thought to be more convenient to study all the muscles of one region at the same time, or before dissecting other parts. In general the most common names—those given by most authors—have been taken. In some few instances I have ventured to propose a name. In these cases I have put an interrogation point after the name; and mean to ask if the name proposed will be a suitable one.

MUSCLES OF THE BREAST.

Pectoralis Major.
Pectoralis Minor.
Coracobrachialis.
Sterno-coracoid(?)
Sub-coracoid(?)
Serratus.

MUSCLES OF THE ARMS.

Tensor Plicæ Alaris Longus.
Tensor Plicæ Alaris Brevis.
Biceps.
Triceps.

MUSCLES OF THE ELBOW JOINT.

Supinator.
Flexor Antibrachii Tertius?
Brachialis Internus.

MUSCLES OF THE SHOULDER.

Latissimus Dorsi.
Trapezius.
Rhomboideus.
Levator Scapulæ.
Teres Major.
Infraspinatus.
Subscapularis.
Deltoid Major.
Deltoid Minor.

MUSCLES OF THE FOREARM.

Pronator Brevis.
Pronator Longus.
Extensor Metac. Rad. Longus.
Extensor Metac. Rad. Brevis.
Flexor Metacarp. Ulnaris.
Flexor Metacarp. Radialis.
Extensor Carp. Ulnaris.
Extensor Com. Longus.
Extensor Dig. Indicis Proprius.

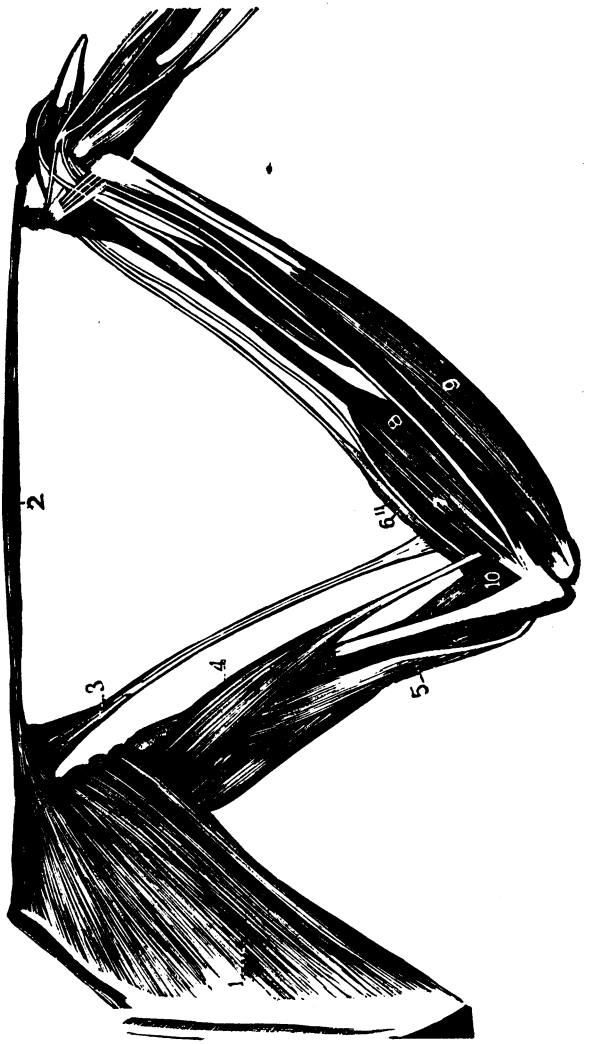
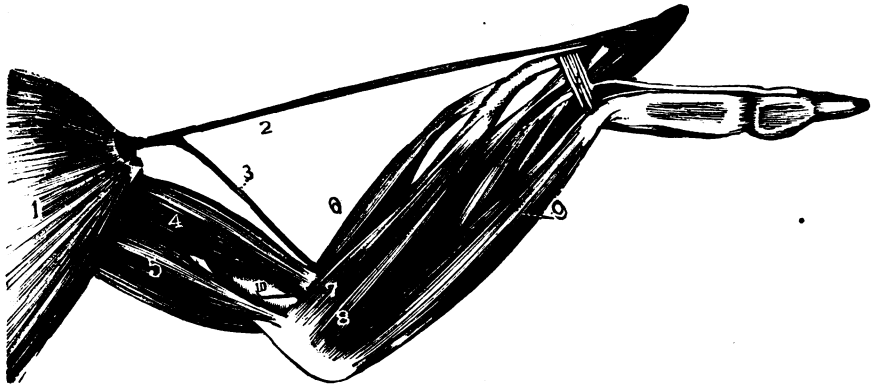


FIG. 14.—AQUILA FUCOSA, (ANTERIOR VIEW.) FROM MILNE-EDWARDS, AS FIGURED BY SELENKA.

FIG. 15.—GALLUS DOMESTICUS (ANTERIOR VIEW.)



1. Pectoralis major.
2. Tensor Patagii longus.
3. Tensor Patagii brevis.
4. Biceps.
5. Triceps.
6. Extensor Carpi radialis.
7. Pronator brevis.
8. Pronator longus.
9. Flexor Carpi ulnaris,
10. Brachialis internus.
11. (Fig. 14.) Extensor Metac. Rad. longus,

THE PECTORALIS MAJOR.

[The Pectoralis Major and Minor.—*Selenka.* The Pectoralis Maximus.—*Coues.*]

The pectoralis major is the largest muscle of the body and constitutes the outer portion of the breast of the chicken. It is triangular in shape; one side of this triangle being represented by the clavicle and the membrane extending from the keel of the sternum to the clavicle; a second side, by the keel of the sternum; while the third and longest side of the triangle may be represented by a line drawn from the insertion of the muscles on the ridge of the bicipital fossa of the humerus to the posterior extremity of the keel. Along parallel with and just inside of this longest side, passes the tendinous part of the muscle, which is plainly seen on both the upper and under face of the muscle. Fibres from the three sides unite to form this tendon, which becomes broader as it approaches the humerus, where it is inserted upon the superior lip of the bicipital fossa.

Relations.—By its exterior face with the superficial fascia and the integument. By its interior face with the pectoralis minor, the coracobrachialis, the ribs and the intercostal muscles; also near its insertion, it lies across the bicipital fossa, and consequently over the tendons of the biceps.

Use.—It serves to draw the humerus down, and is one of the most powerful muscles of flight. It seems from its position and use, to be the homologue of the two pectoral muscles in man.

Dissection.—Make an incision along the entire length of the keel, at the same time, pulling the muscle from the

keel. When the incision has reached the pectoralis minor, the major easily separates from that muscles. A second incision is made along the furculum, then beginning at the posterior extremity of the keel, the muscle is raised exposing the pectoralis minor and the coracobrachialis.

PECTORALIS MINOR.—DELTOIDES MAXIMUS (?)

[Subclavius.—*Selenka.* Pectoralis Secundus.—*Owen.* Pectoralis Medius.—*Coues.* Subclavius.—*Rolleston.*]

The pectoralis minor lies directly under the preceding muscle, and like it is triangular in shape; but thicker and not so broad. It arises by fleshy fibres from the lower part of the side of the keel and from the body of the sternum. It is small and narrow at its posterior extremity, but grows wider until it reaches the clavicle and coracoid, then again becomes narrow, terminating in a long tendon, which passes upward through the foramen triosseum, then turns downwards, and is inserted on the humerus just above the insertion of the pectoralis major.

Relations.—By its superior face, with the pectoralis major; by its interior face with the mesial part of the sternum through the entire length of that bone, and with the sternal end of the coracoid; by its sternal border with the greater part (all not occupied by the major) of the keel; by its costal border, with the costal muscles, and anteriorly with the coracobrachialis, the dividing line between these two muscles being plainly visible along the length of the coracoid bone.

Use.—It rotates and elevates the humerus and produces

the upward stroke of the wing during flight. The foramen triosseum through which the tendon of this muscle passes acts as a pully and changes the direction of the force. Thus these two large muscles, though they rise and lie in the same region, act in directly opposite directions. This muscle is called the subclavian by Selenka in "Bronn's klassen und Ordnungen des Thier-reichs," and Rolleston has shown that it is furnished with the same nerve by which the subclavian in man is furnished. Therefore both of these eminent authors consider this muscle the homologue of the subclavian in man. But the action of the subclavian in man simply depresses the shoulder; while the use of the muscle under consideration is to rotate and elevate the wing. Certainly so far as action is concerned, this muscle resembles the deltoid more closely than the subclavian. Its direction of action from the foramen triosseum—which Selenka says must be considered as a fixed point to its insertion corresponds with the direction of the action of the deltoid more closely than with that of any other muscle. Moreover its extensive origin, its lying both anterior and posterior to the humerus does not correspond to the subclavian, but rather to the deltoid. From these considerations, I consider the muscle a deltoid, and would call it Deltoides maximus. This is the name given it by Schoepss; but I have never seen his work, and do not know his reason for so naming it. Selenka merely gives it as a name proposed by Schoepss. Selenka says: "Vergleicht man die Ursprungsfläche des Subclavius (our deltoid) der Vögel mit der der Säuger und Reptilien, so befremdet die breite Insertion auf dem Brustbeine, wie sie bie den Vögeln sic findet. Doch ist auch hier keine Schwierigkeit die Homologie anzuerken-

nen den bein Emu is die Sternalportion des Subclavius (our deltoid) schon sehr klein, und beim Strausse, wo doch ein deutlicher Subclavius vorhanden ist, fehlt die Sternalportion total. So kann der Subclavius vom Sternum, Coracoid und Scapularande kommen." Here he says that the muscle can come from the sternum, coracoid and scapular margin, and that the sternal portion may be entirely absent. The subclavian in man arises from the cartilage of the first rib and makes its insertion on the middle third of the clavicle The deltoid in man arises from the clavicle, the acromion process and the spine of the scapula. It is evident from this that the muscle under consideration, has its origin more in accordance with the deltoid than the subclavian.

Dissection.—First separate the coracobrachialis, the dividing line being plainly visible along the entire length of the coracoid bone—then beginning at the posterior extremity, raise the muscle separating from that bone and proceeding forwards. The action of its tendon should be carefully noticed.

THE CORACO-HUMERALIS.—MECKEL.

[The Coracobrachialis. Pectoralis Minimus.—*Coues.* Coracobrachialis Longus.—*Selenka.*]

This muscle, or the fleshy part of it, has the shape of an inverted isosocles triangle. The apex of this triangle lies at the base of the coracoid, where that bone attaches to the sternum, while the base of the triangle lies directly under the head of the coracoid. The two equal sides are between two and three inches in length. The base which measures the widest part of the muscle is about one-half inch in

length. The muscle arises fleshy from a small part of the sternum—contiguous to the base of the coracoid—from the base, and the entire length of the shaft of the coracoid. From the outer angle at the base of the triangular fleshy part, a strong tendon passes upward and makes its insertion on the internal tuberosity of the humerus.

Relations.—By its superior face with the pectoralis major, by its inferior face with the sterno-coracoid and the coracoid bone; by its inner border with the pectoralis minor, while its outer border is covered with the pectoralis major.

Use.—It depresses the humerus, and at the same time rotates it from without within or towards the body.

Dissection.—Separate from the sternum and coracoid and raise.

STERNO-CORACOID(?)

[Coraco-Sternalis.—*Selenka.*]

This is a small muscle about one inch wide, and one-fourth of an inch long. It lies in the angle between the anterior costal process of the sternum and the coracoid bone. Although a very small and short muscle, it is proportionally quite thick and strong. Since in the domestic fowl this muscle is always attached to the process of the sternum, and not to the sternal ribs, as is the case with birds of prey; the coracoid must be the bone moved by its action. Therefore I consider the muscle as arising from the anterior costal process of the sternum, and inserting on the edge of the coracoid from its base to one-half to two-thirds of its length. Considering its origin to be on the sternum and insertion on the coracoid, we have taken the lib-

erty of changing the name, in the case of the domestic fowl, from coraco-sternalis, as given by Selenka, to sterno-coracoid. Indeed Selenka says, in speaking of the action of this muscles in the different kind of birds: "Der Coraco-sternalis wirkt übrigens auch auf das in geringem Maasse bewegliche das Sternum zieht, und bie Tauben und Huhnern wo die Rippenzachen des muskels fehlen, ist die seine Hauptwirkung."

Relations.—By its superior face with the coraco-brachialis; by its inferior face with the thoracic cavity.

Use.—It draws the coracoid bone upward and backward.

SUBCORACOID.

[Coraco-brachialis brevis.—*Selenka.*]

This muscle lies under the coracoid bone. It arises from the inner surface of the sternum, along its anterior border; also from the under or inner surface of the coracoid bone. It passes obliquely upwards and outwards and makes its insertion by a short but strong tendon, on the middle tubercle of the external face of the head of the humerus. This tendon often unites with that of the subscapularis and the two then have a common insertion. The action of this muscle is the same as that of the coracobrachialis, and it only assists that muscle.

LATISSIMUS DORSI.

This muscle consists of two parts which have separate origins; but become one before making the insertion. The

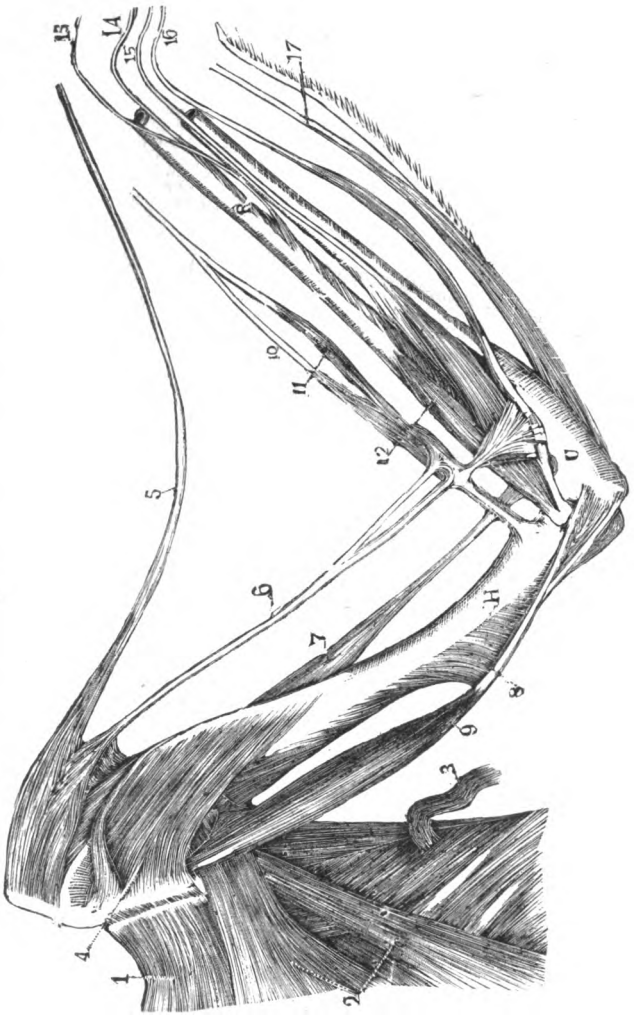
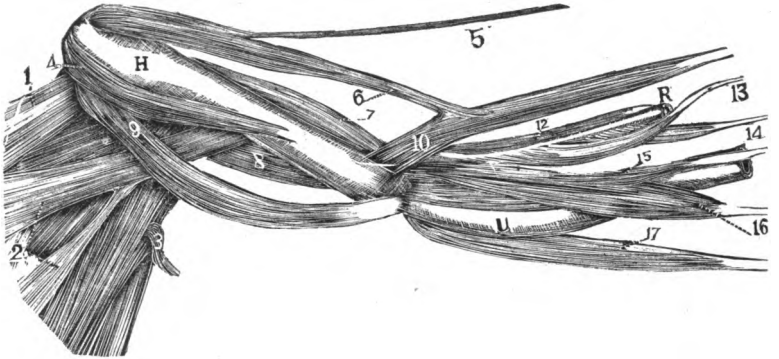


FIG. 16.—HAWK (POSTERIOR VIEW.) FROM MILNE-EDWARDS, AS FIGURED BY SELENKA.

FIG. 17.—GALLUS DOMESTICUS (POSTERIOR VIEW.)



1. Trapezius.
2. Latissimus dorsi.
3. Tensor Membranæ Posterioris Alæ.
4. Deltoides.
5. Tensor Patagii longus.
6. Tensor Patagii brevis.
7. Biceps.
8. Triceps.
9. Anconeus longus.
10. Extensor Metacarpi radialis longus.
11. (Fig. 17.) Extensor Carpi radialis.
12. Supinator.
13. Extensor Pollicis longus.
14. Extensor Dig. indicis proprius.
15. Extensor Digitorum Com. longus.
16. Extensor Carpi ulnaris.
17. Flexor Carpi ulnaris.

anterior portion arises from the dorsal spines of three vertebræ opposite the middle portion of the scapula. From its origin to the edge of the scapula, this portion lies directly over the trapezius. It is thin, ribbon-like and passes directly across the scapula and attached muscle, then between the two parts or muscles forming the triceps, and makes its insertion upon the back part of the humerus, directly beneath the insertion of the deltoid and just over the fleshy part of the triceps, about one-third the distance down that muscle from its origin to its insertion on the ulna. The posterior or inferior portion of the latissimus dorsi, arises from the processes of the first two or three vertebræ immediately in front of the origin of the sartorius. It passes upwards and outwards joining the anterior portion at or near its middle point. The anterior portion becomes some narrower but thicker, from its origin to its insertion; but its width at the point of insertion is not less than two-thirds of what it is at the point of origin. The posterior portion, at its origin, has about the same width and thickness as the anterior one, where it arises; but it gradually grows smaller and becomes very small and weak before joining the anterior portion. Indeed one must be cautious in removing the integument of this region, preparatory to examining these muscles, or he will tear the posterior portion from the anterior, since it becomes so small and weak. These two portions, taken together, constitute the homologue of the extensive muscle, known as the latissimus dorsi in human anatomy. In most of birds, the two portions of this muscle, are separate throughout their entire length, and also insert separately, the posterior portion inserting close by, sometimes under the

insertion of the anterior portion. This muscle draws the humerus back towards the scapula.

TRAPEZIUS.

[Cucullaris.—*Selenka.*]

This is a very broad, thin, and short muscle. It arises from the processes of the lower cervical, and of the anterior dorsal vertebræ, and makes its insertion on the humeral end of the clavicle, and along the dorsal edge of the scapula, throughout the entire length of that bone with the exception of the extreme posterior extremity. Often there seems to be two parts to this muscle, the anterior portion being a narrow band, which passes from the cervical vertebræ. and makes its insertion on the end of the clavicle, and separate from the remaining and greater portion of the muscle. This division into two parts, does not always occur, by any means. The fibres of this muscle pass upwards and outwards. The muscle draws the scapula towards the vertebral column, and is the homologue of the trapezius in man. When this muscle has been raised the romboideus is exposed.

RHOMBOIDEUS.

This muscle lies directly under the preceding one, but it is much smaller and its fibres pass in an opposite direction —downwards and outwards—from those of the trapezius.

Its name indicates its shape, and its width is about three or four times its length. It arises from the spines of the

anterior dorsal vertebræ, and its fibres pass downwards and outwards, making an insertion upon the dorsal edge of the scapula, along the posterior two-thirds of the length of that bone. It serves to lift the scapula and to draw its posterior extremity forward.

TERES MAJOR.

This is a large, broad and thick muscle. It arises from the superior face of the scapula, from its posterior extremity to within one-fourth of an inch of the head of that bone, and inserts by a strong tendon upon the outer edge of the internal tuberosity of the humerus, just over the depression corresponding to the foramen pneumaticum. This tendon or its insertson, is hidden by the short head of the biceps, which inserts fleshy at the same place. This muscle has almost or quite the shape of a right-angled triangle, with the right angle at the point of its insertion, the dorsal edge of the scapula for its hypotenuse, a straight line from the posterior extremity of the scapula to its insertion on the humerus, for the perpendicular, and another straight line from the highest point of its origin on the scapula to its insertion, for the base. Along parallel with the perpendicular, lies the tendinous part of the muscle, which can be seen for one half the distance from the insertion to the posterior extremity of the scapula. The fibres from the extensive origin converge to form this tendon, those from the base, or along the base of our triangle, joining the tendon at right angles. This muscle draws the humerus back towards the scapula, and at the same time rotates it inwards. It is the most powerful muscle which is attached to the scapula.

INFRASPINATUS.

Just along and under the base of the supposed triangle, under which form we have represented the preceding muscle, will be found a very small muscle, which arises from the inner edge of the scapula, directly under the highest point of the origin of the teres major, and passes along directly under the base of the same muscle, inserting at the opening of the foramen pneumaticum, where the short head of the triceps arises.

SUBSCAPULARIS.

Directly under the preceding muscle, will be found another muscle. It is triangular in shape and arises from the under surface of the scapula, from the head of that bone, down its length about one inch. The fibres from eaeh extremity of its origin converge, forming a tendon which makes its insertion on the middle tuberosity of the posterior face of the head of the humerus.

DELTOID MAJOR.

This muscle arises from the head of the scapula and from the end of the clavicle, the latter being its principal origin. Its origin on the end of the clavicle lies side by side with the origin of the tensor plicæ alaris. It passes over the shoulder joint fleshy, and inserts upon the back side of the humerus about half way down the shaft of that bone. It lifts the humerus, and at the same time throws the distal end of that bone backwards and outwards.

DELTOID MINOR.

There is a small muscle, or what seems to be part muscle and part ligament, which passes from the head of the scapula and inserts on the head of the humerus. It assists in forming the shoulder joint.

TENSOR PLICÆ ALARIS LONGUS.—(OWEN.)

[Tensor Longus Patagii Membranæ Anterioris Alæ.—*Selenka.*]

This and the following muscle arise in common from the extreme point of the clavicle, where that bone joins the extremities of the coracoid and scapula. They pass over the shoulder joint in a broad, thin band. As this band passes over the insertion of the pectoralis major it receives from the humerus a small but strong tendon which comes up up through the tendinous part of the pectoralis major. Just beyond this point, the broad band becomes divided into two distinct muscles. One of these—the tensor plicæ alaris longus—passes directly across to the distal end of the radius, or rather beyond this, to the metacarpal of the thumb or false wing. Therefore it passes along the integument where it folds back upon itself. This muscle is very poorly developed, and is separated from the integument with the greatest difficulty. It is almost impossible to remove the integument without removing the muscle with it. When it has been freed from the integument it is found to be only a smooth thread of muscle. It serves to fold the skin which is stretched in the angle formed by the arm and fore-arm, when held in their usual position.

TENSOR PLICÆ ALARIS BREVIS.—(OWEN.)

[Tensor Brevis Patagii Membranæ Anterioris Alæ.—*Selenka.*]

The origin of this muscle has been given with that of the preceding one. After the broad band has been divided, this muscle takes a direction almost parallel with the humerus. though some distance from the bone. It passes downwards and inserts into the extensor metacarpi radialis just beyond the origin of that muscle.

BICEPS.

The biceps is a long muscle occupying the entire anterior aspect of the humerus. It arises by two heads, from which fact it receives the name of biceps. The short head arises from the upper face of the internal tuberosity of the humerus. The long head arises from the head of the coracoid bone, passes over the shoulder joint, then along the bicipital fossa of the humerus. Here it unites with the short head. (It would probably be more correct to represent the origin of this muscle as from a single tendon, which leaves the coracoid bone, narrow, widens as it passes over the head of the humerus, and is attached to that bone; then again becomes narrow. Most of authors speak of the two heads of the biceps, and for this reason I have so given it.) The two form the fleshy belly of the muscle. This terminates in a flat tendon, which makes its insertion on the posterior part of the tuberosity of the radius. This tendon often divides, the second portion being attached to the ulna. The origin and broad tendon of the biceps, as it passes over the head

of the humerus, is covered by the pectoralis major. Through the remainder of its extent, it is covered only by the integument and superficial fascia, while the internal face of the muscle rests upon the humerus. It flexes the fore-arm—folds the wing.

TRICEPS.

This muscle in birds consists of two distinct parts, having both separate origins and insertions, and are separate throughout their entire length. The longer one—which Selenka gives as the *anconeus longus*—rises from the neck of the scapula, is quite large and fleshy, and passes down along the posterior face of the humerus. When it reaches the elbow it spreads out iuto a thin fascia, which seems to unite with the fibres of the various muscles of the fore-arm; but the principal insertion of the muscle seems to be on the external side and at the base of the olecranon process.

The shorter muscle arises by two heads. The shorter of these two heads, arises from the outer side of the internal tuberosity of the humerus, where the strong tendon of teres major inserts, and from the adjoining depression, which corresponds to the pneumaticum foramen. The longer head arises higher up on the external face of the head of the humerus, just under the external tuberosity. The two heads unite and receive fibres from the broad face of the head of the humerus, and from the shaft of the same bone through the upper third of its extent. The muscle near its origin is large and fleshy, but grows smaller, and terminates in a small tendon, which makes its insertion on the olecranon process. These two muscles occupy the entire external or

posterior face of the humerus, and the two taken together, may be considered as the homologue of the triceps in man. It serves as in man to extend the forearm, and is the opponent of the muscle occupying the anterior or internal face of the humerus,—the biceps.

SUPINATOR.

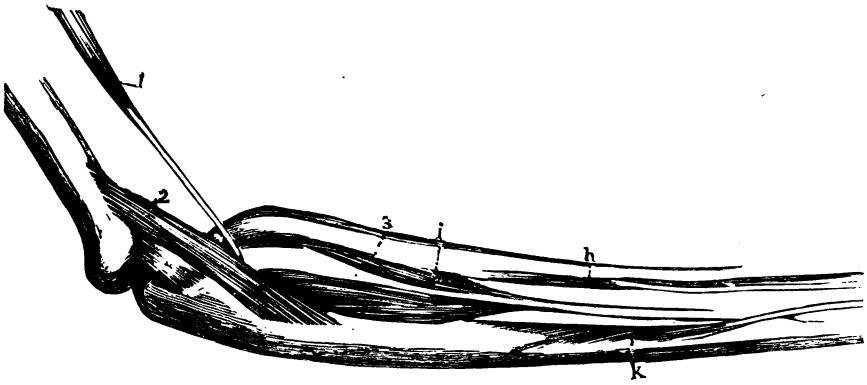
This small muscle arises by a short tendon from the outer condyle of the humerus, and inserts on the outer edge of the radius from the neck of that bone for two-thirds its length. It throws the upper edge of the radius outwards, thus acting as a supinator.

FLEXOR TERTIUS ANTIBRACHII.

[Flexor Profundus Interior Gallinaceorum.—*Selenka.*]

This is a very small muscle, not found in most of birds; but always present in the domestic fowl. It arises from the internal condyle of the humerus, and inserts upon the inner edge of the ulna. It is about one inch, or an inch and a half long, measuring from its origin to the farthest part of its insertion; but from its origin to the nearest point of insertion is not more than half an inch. It flexes or folds the forearm, and from its action I have taken the liberty of giving it the name, *flexor tertius antibrachii.*

FIG. 18.—AQUILA FUCOSA. FROM MILNE-EDWARDS, AS FIGURED BY SELENKA.



1. Biceps.
2. Brachialis Internus.
3. Supinator.
h. Deep External Flexor of the Hand
i. External Extensor of the Hand
k. Internal Extensor of the Hand.

BRACHIALIS INTERNUS.

This is a small, short, ribbon-like muscle, which arises from the supracondyloid depression, and inserts upon the internal face of the ulna. Its insertion is covered by that of the flexor tertius antibrachii, and the latter should be examined and removed before this one is. Its length is not more than an inch, and its width is about one-third its length. It has no tendon, but is fleshy both at its origin and insertion.

THE EXTENSOR METACARPI RADIALIS LONGUS.

This muscle arises from the external condyle of the humerus, passes along the radius—forming the radial border of the muscular part of the forearm—over the wrist joint and the carpal bone, and makes its insertion upon the radial edge of the metacarpal of the thumb or spurious wing. It is small and tendinous at its origin, but soon becomes fleshy and so continues until it has nearly reached the distal extremity or the radius; here it is joined by the tendon of the extensor metacarpi radialis brevis, and the two forming a broad and strong tendon, pass over the carpal joint and make the insertion as given above. At or near its origin this muscle receives the tensor plicæ alaris brevis; the latter muscle inserting into the former. It raises the hand to a level with the radius, and holds it in this position.

EXTENSOR METAC. RAD. BREVIS.

[Extensor Pollicis Longus.—*Selenka.*]

The extensor metacarpi radialis brevis arises from the in-

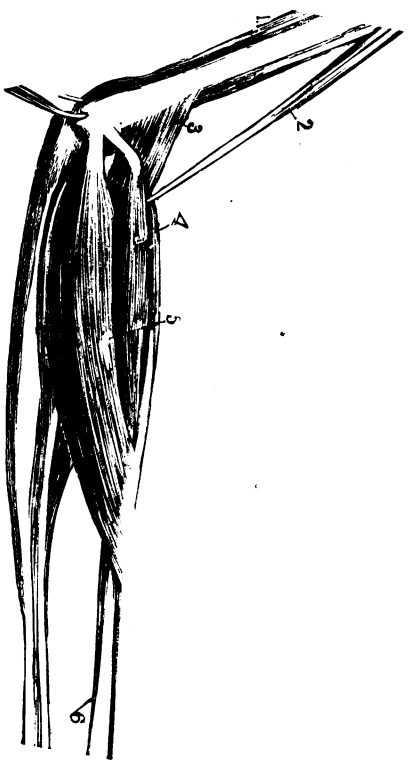
ner or ulnar edge of the radius, along the middle third of that bone. Its tendon passes upwards, obliquely across the radius, and unites with the tendon of the extensor metac. rad. longus, and the two make a common insertion on the metacarpal bone of the thumb. This muscle sometimes has a double origin, the second one being on the radial edge of the ulna, and nearer the elbow joint than the one on the radius. I have given the insertion on the radius as the principal one, because it is always present while the other may be entirely wanting.

FLEXOR METACARPI ULNARIS.

This is the largest muscle of the forearm, and forms the ulnar border of the muscular portion of this region. It arises with a strong tendon from the internal condyle of the humerus, and not from the ulna as given by Owen in his Anatomy of Vertebrates, where he treats of the muscular system of birds in general. It would seem from this, that its origin is different in the domestic fowl from what it is in most other birds. It first inserts upon the carpal and then upon the metacarpal. Instead of lying along the edge of the ulna, it passes along the side; but being flat and between one-fourth and one-half inch wide, it extends down below the edge of the ulna. It flexes the hand or folds the pinion.

PRONATOR BREVIS—PRONATOR LONGUS.

There are two pronators present in the domestic fowl; but from their length alone, one would not be justified in



1. Biceps.
2. Triceps.
3. Brachialis Internus.
4. Pronator Brevis.
5. Pronator Longus.

FIG. 19.—AQUILA FUSCOSA.—From Milne-Edwards, as figured by Selenka.

calling one the pronator brevis and the other the pronator longus; for both are equal, or very nearly equal, in length. From their relative positions, we might call one the superior and the other the inferior; for one lies directly over the other. The superior one corresponds to the pronator brevis and the inferior to the pronator longus of other birds. Both arise from the internal condyle of the humerus and

pass obliquely across the space between the ulna and the radius, and are inserted along the ulnar edge of the radius, from near its proximal end for two thirds of its length.

EXTENSOR CARPI ULNARIS.

The extensor carpi ulnaris arises from the outer condyle of the humerus, and passes fleshy along the middle of the outer side of the forearm, and makes its insertion on the ulnar carpal bone. It is quite strong and is one of the principal extensors of the hand. The tendon of this muscle passes throngh the pulley near the wrist joint.

FLEXOR METACARPI RADIALIS.

This muscle arises from the radial edge of the ulna along the distal half of that bone, passes obliquely upwards through the annular ligament, being so far entirely on the inner side of the arm; but after passing through the annular ligament, it passes under the common tendon of the radial extensors at the base of the thumb, and is inserted externally on the first metacarpal bone.

EXTENSOR DIG. COM. LONGUS.

This muscle arises with the supinator on the radial condyle of the humerus, passes down along the middle of the backside of the forearm through the annular ligament, then divides into two parts, one of which inserts on the thumb, the second on the base of the metacarpal of the long finger.

EXTENSOR DIG. INDICIS PROPRIUS.

This muscle arises from the lower third of the ulnar edge of the radius and inserts upon the long finger.

THE MUSCLES OF THE POSTERIOR EXTREMITIES.

These muscles are arranged in the order which it is believed will be found most convenient to follow in dissecting.

Abductor Magnus.
Sartorius.
Biceps.
Semitendinosus.
Adductor Longus.
Adductor Brevis.
Obturator.
Semimembranosus.
Glutei.
Gracilis.
Crureus
Vastus Externus.
Vastus Internus.
Quadratus.
Adductor Magnus
Gastrocnemius.
Peroneus Longus.
Tibialis Anticus.
Extensor Lon. Dig.
Soleus.
Flexor Perforans Dig.
Flexor Perforatus Dig.
Peroneus Medius.

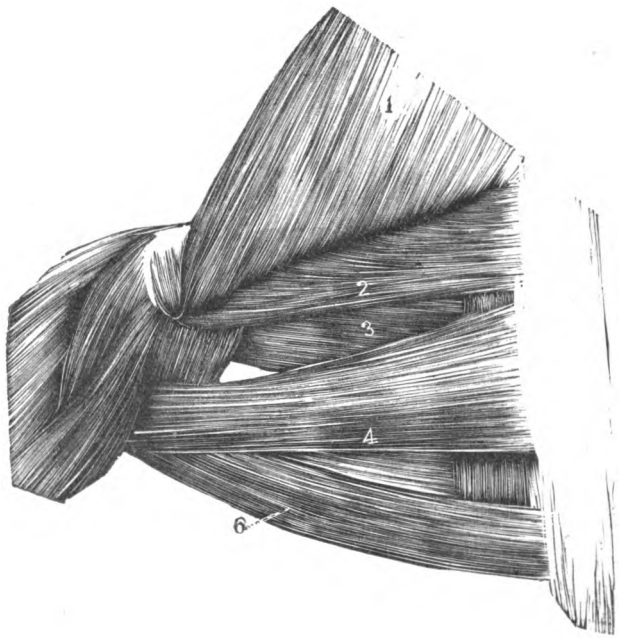
ABDUCTOR MAGNUS.—(OWEN.)

[Rectus Femoris.]

The abductor magnus or rectus femoris, is the most extensive muscle of the leg. It together with the sartorius, with which it is continuous anteriorly, forms the broad triangular external surface of the thigh. It arises from the prominent irregular ridge of the pelvis. The fibres converge and extend over the knee-joint. About two-thirds the distance from the origin to the knee, the muscle may be divided into two parts. The anterior part terminates in a thin aponeouorosis, which closely adheres to the underlying

muscles, spreads out over the knee-joint and inserts upon the patella and head of the tibia. The posterior portion is

FIG. 20.—MUSCLES OF THE THIGH—(POSTERIOR VIEW.)



1. Rectus Femoris. (Raised.)
2. Vastus Externus.
3. Adductor Magnus.
4. Biceps.
5. Semimembranosus.
6. Semitendinosus.

more fleshy and makes its insertion upon the head of the fibula. Some authors consider these as two distict mnscles. They name the anterior portion the rectus femoris and the

posterior portion the tensor vaginae. Concerning the functions of this muscle Owen says; "Owing to the great antero-posterior extent of the origin of this muscle, its anterior fibres are calculated to act as a flexor, its posterior ones as an extensor of the femur; all together combine to abduct the thigh and extend the leg, unless when this is in a state of extreme flexion, when a few of the posterior fibres glide behind the center of motion of the knee joint."

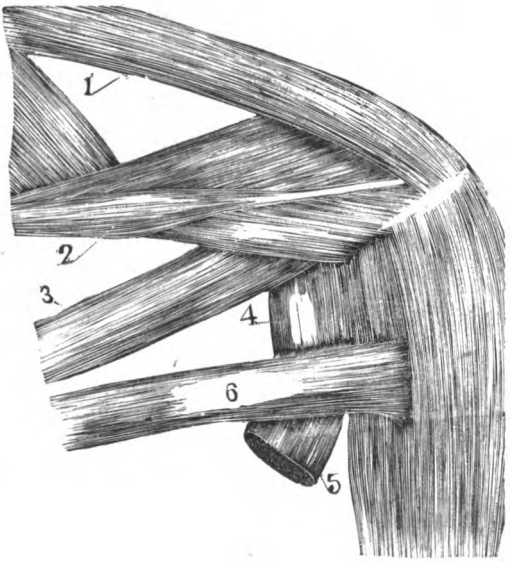
Relations.—By its superior face with the integument, by its under surface, with the semitendinous, biceps, vastus, cruraeus, and the glutaei; by its anterior border, with the sartorius.

Dissection.—Place the subject upon the back, and with the head to your right hand, if dissecting the right leg. Separate the posterior border from the underlying muscles by pulling it forward; then make an incision along the line of origin.

SARTORIUS.

Arises from the anterior part of the labrum of the ilium. At its origin, it is continuous with the abductor magnus. As it descends, it becomes narrower and thicker. For the lower two-thirds of its course, it can be easily separated from the abductor magnus. It passes around in front and lies partly under the thigh. It makes its insertion by a strong tendon upon the internal side of the anterior face of the tibia. The insertion is covered by the internal head of the gastrocnemius.

FIG. 21.—MUSCLES OF THE THIGH. (ANTERIOR VIEW.)



1. Sartorius.
2 Gracilis.
3 Adductor Magnus.
4. Accessorius Semitendinosi
5. Semitendinosus.
6 Semimembranosus.

Use.—It adducts the thigh and extends the leg.

Relations.—By its upper face, with the integument; by its under surface, with the glutæus medius and internus, the cruræus and vastus internus; by its posterior border, with the abductor magnus.

The fibres at the origin of the sartorius are intermingled with those of the gluteus medius, so that great care must be used in separating these two muscles. The sartorius does not always cover the gluteus internus.

BICEPS.

This nicely formed muscle lies directly under the abductor magnus, and is exposed when that muscle is raised. It arises from the prominent part of the ridge of the pelvis, which lies just behind the acetabulum and above the sciatic foramen. It is often an inch broad at its origin. Its fibres converge, pass throngh a loop, formed by a ligament which is attached at one end to the outer condyle of the femur and and at the other to the head of the tibia. The muscle is then inserted by a strong tendon to the fibula. It is evident from the description that the muscle is unicipital.

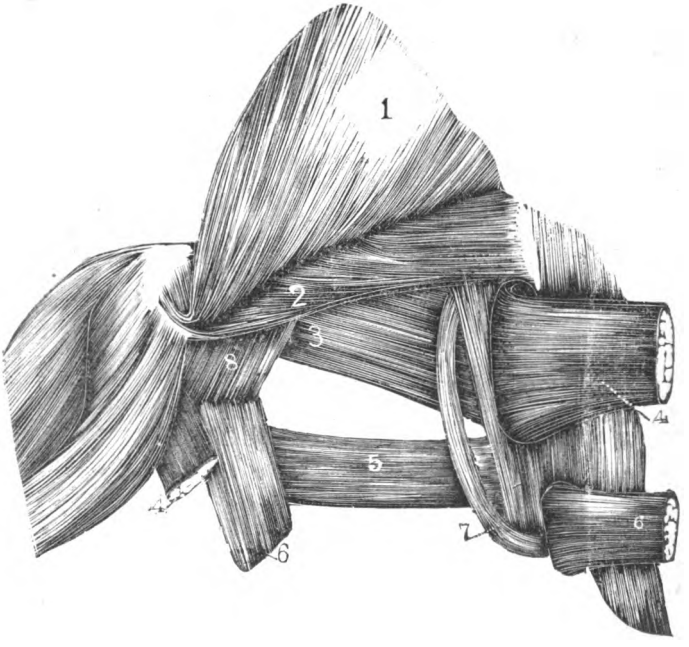
Owen says: "By means of the loop, the weight of the hinder part of the body is partially transfered, when the leg is bent, to the distal end of the femur, and the biceps is able by the samc beautiful mechanism to effect a more rapid and extensive inflection of the leg than it otherwise could have produced by the simple contraction of its fibres."

According to Selenka the size of this muscle is very variable. It is broad in the domestic fowl, in birds of prey, änd in the penguin. In the *Struthio* and the *Apteryx*, a branch is given off from the tendon of the biceps just above the loop. This branch unites with the fleshy part of the gastrocnemius. Indeed some authors describe this branch as a separate muscle. The loop through which the tendon of the biceps passes is also of very variable length. Selenka states that the tendon of the biceps is strongest and the loop longest in the *natatores*. This is necessary since the biceps is one of the most important muscles used in swiming.

SEMITENDINOSUS.

Arises from the caudal vertebræ and from the posterior end of the ilium. Its proximal two-thirds lie posterior to the biceps; its distal third passes under that muscle. Near its insertion it sends up a broad thin muscle, the accessorius semitendinosi, which inserts into the femur. The semitendinosus inserts upon the angular ridge of the head of the tibia.

FIG. 22.—MUSCLES OF THE THIGH. (POSTERIOR VIEW.)



1. Rectus Femoris. (Raised.)
2. Vastus Externus.
3. Adductor Magnus.
4. Biceps.
5. Semimembranosus.
6. Semitendinosus.
7. Adductor Longus.
8. Accessorius Semitendinosi.

THE ADDUCTOR LONGUS

is a long, narrow, ribbon-like muscle. It arises from the caudal region, under and a little posterior to the origin of the semitendinosus, passes around over the posterior part of the ischium, across the semimembranosus at its origin, over the adductor magnus, and inserts into the proximal end of the femur. It draws the thigh backwards.

ADDUCTOR BREVIS FEMORIS

is a very thin muscle which arises from the posterior end of the ischium directly under the posterior point of the ilium. Its inferior border touches, and partly covers the adductor longus. It extends forwards and inserts near by or in common with the preceding muscle. Its use is the same as that of the adductor longus.

OBTURATOR.

Arises from the broad depression on the ischium, posterior to the sciatic foramen, passes forward and inserts into the femur near its proximal end. This muscle is covered by the preceding one. It draws the femur backwards and turns it outwards.

SEMIMEMBRANOSUS.

If the muscles have been removed in the order here given, the semimembranous will be the most posterior one remain-

ing. It arises from the inferior edge of the ischium, is of nearly uniform width and thickness throughout its entire length, and inserts in common with the semitendinosus, with which it corresponds in function.

THE GLUTÆI.

These muscles, three in number, arise from the side and floor of the depression, which marks the ilium anterior to the acetabulum. They insert upon the femur.

The glutæus externus is smaller than the glutæus medius. It takes origin from the posterior end of the depression and from the ridge directly over the acetabulum. It passes down over the joint and partly overlaps the glutæus medius. It inserts by a strong tendon into the femur below the trochanter. It lifts and abducts the femur.

The glutæus medius is the largest of the three. It is triangular in shape, with the line of its origin for the base and the point of insertion for the apex. It arises along the entire length of the depression, and inserts upon the great trochanter. It draws the thigh forwards, and at the same time rotates it inwards.

The glutæus internus is partly covered by the preceding muscle. It arises from the anterior part of the ventral edge of the ilium, passes backwards and inserts under the glutæus medius.

GRACILIS.

This small muscle lies along the inner side of the thigh and over the vastus internus. It arises from the os pubis

and often has another head from the proximal end of the the femur. Either of these heads may be wanting. It soon becomes converted into a small tendon, which inserts upon the patella or its ligament.

CRURÆUS.

This is a large muscle which lies along the femur. It arises from the proximal end of the femur and closely adheres to that bone throughout its entire length. It not only covers the bone, but extends out over the vastus externus and internus, with the former it is often closely united. It inserts upon the ligaments of the patella and upon the head of the tibia.

THE VASTUS EXTERNUS

lies along the outside of the femur, is closely connected with the cruraeus and inserts with that muscle.

THE VASTUS INTERNUS

lies directly under the gracilis and along the inner side of the femur. It arises from the inner side of the proximal end of the femur, lies close to the bone along its entire length, and inserts upon the ligaments of the knee-joint and upon the inner side of the anterior face of the head of the tibia.

QUADRATUS FEMORIS.

This muscle lies along with the adductor magnus. It is

broad, thin, and arises from the inferior edge of the ischium posterior to the foramen ovale, and inserts into the distal half of the femur. It lies under the thigh and draws it inwards and backwards.

ADDUCTOR MAGNUS

has its origin under that of the preceding muscle, arising from the edge of the ischium and from the os pubis. It is broader than the quadratus, and has a more extensive insertion. It inserts along the distal half of the femur, on its interior face. It adducts the thigh.

MUSCLES OF THE FORELEG.

GASTROCNEMIUS.

This is a powerful muscle, and as in mammals, consists of two parts. One portion lies on the inner side of the leg, and another on the outer side. The former is called the gastrocnemius internus, and the latter the gastrocnemius externus.

The gastrocnemius internus arises by two heads. The smaller head takes its origin from the internal condyle of the femur. Its fibres pass downwards, converge, and unite with those of the other head. The larger head arises from the patella, the ligaments of the knee-joint, and the anterior part of the head of the tibia. It partly overlaps the muscles, which lie along the anterior face of the tibia. About three-fonrths the distance down the tibia, it meets its fellow from the external side and the two form a broad, strong ligamentous aponeurosis, which extends over the posterior surface of the tarso-metatarsal bone.

The gastrocnemuis externus arises by a strong tendon from the external condyle of the femur, becomes fleshy, then narrow and tendinous, and terminating as given above. The ligamentous aponeurosis forms a sheath which encloses the tendons of other muscles, as they pass over the ankle joint.

PERONEUS LONGUS

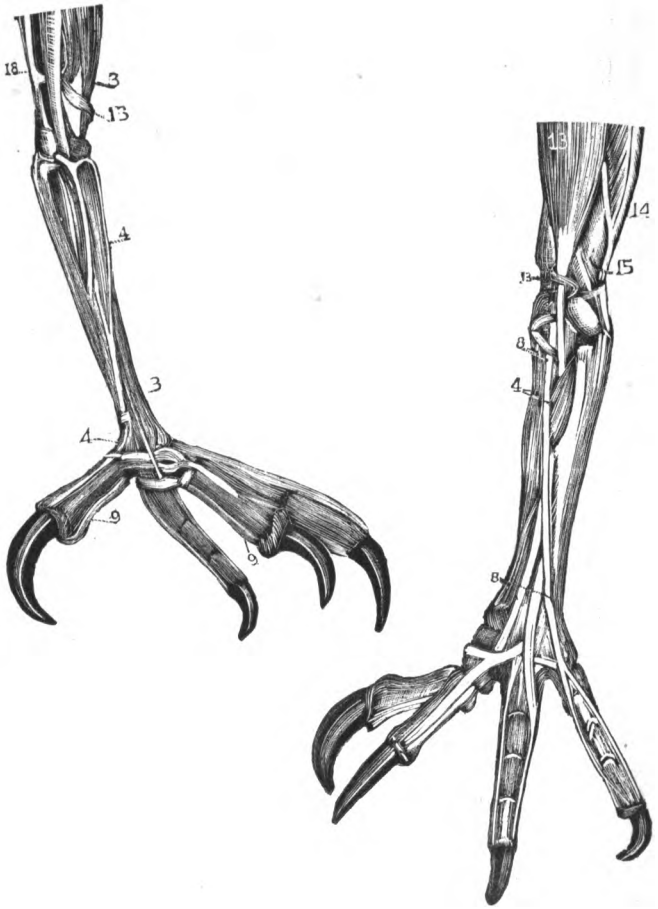
is a superfiicial muscle and partly overlaps the tibialis anticus. It lies on the external side of the face of the tibia. It arises tendinous from the head of the tibia and terminates in a broad ligamentous aponeurosis which inserts upon the external side of the tarso-metatarsus just below the ankle-joint.

THE TIBIALIS ANTICUS

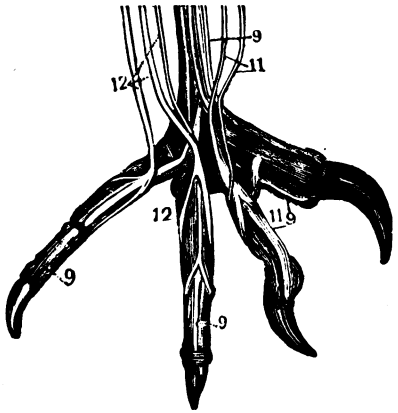
occupies the anterior aspect of the tibia. It arises from the head of the tibia, is large and fleshy in its superior part, then becomes small and tendinous. Just above the ankle-joint it passes under the oblique ligament which crosses the median fossa at the distal end of the tibia. The tendon after passing under the ligament and over the joint, inserts into the groove on the anterior face of the tarso-metatarsal bone. It flexes the tarso-metatarse.

This is, in most birds, a very strong and powerful muscle, being the chief means of flexing the tarso-metatarsal bone, and with it tne entire foot.

FIGS. 23, 24, 25.—AQUILA FUCOSA. (From Milne-Edwards as figured by Selenka.)



3. Abductor Minimi Digiti. 4. Extensor Proprius Pollicis. 8. Extensor Communis Digitorum. 9. Flexor Perforatus Digitorum. 11. Flexor Perforatus Minimi Digiti. 12. Flexor Perforans Digitorum. 13. Tibialis Anticus. 14. Superior Peroneus. 15. Inferior Peroneus, 18. Internal portion of the Gastrocnemius.



EXTENSOR LONGUS DIGITORUM.

[The Extensor Communis Digitorum. (?)]

lies along the anterior face of the tibia, on the internal side of the preceding muscle. It arises from the anterior part of the head of the tibia, along the external side of the anterior eminence. It passes straight down the tibia and becomes tendinous. Its tendon lies deeper than that of the preceding muscle and passes under the osseous bridge which crosses the median fossa at the distal end of the tibia. It then passes between the condyles, over the joint and down the anterior face of the tarso-metatarse, to be distributed to the toes. About half way down the tarso-metatarsal bone, the tendon divides into two branches, an external and an internal. At the distal end of the tarso-metatarsal bone, each of these branches subdivides, the external sending one prong to the fourth toe, and another to the third toe, the internal sending one prong to the second toe, and another to

FIG. 26—MUSCLES OF THE FOOT. (Anterior View.)

the third toe. This muscle extends all the toes. Very often the branches which are sent off from the tendon, are distinct from the main tendon and arise along the tarso-metatarse. When this is the case, it would be better to designate this muscle as the extensor longus digitorum, and the principal short one as the extensor brevis digitorum.

SOLEUS

lies directly under the Gastrocnemius internus. It arises from the posterior part of the head of the tibia, is closely adherent to the Gastrocnemius along and under its posterior border. It soon becomes a strong, round tendon which unites with the Gastrocnemius just above the tarsal-joint.

FLEXOR PERFORANS DIGITORUM

arises from the outer condyle of the femur just anterior to the origin of the Gatrocnemius externus. It is quite fleshy at first, but about half way down the leg becomes tendinous.

The tendon passes over the tarsal-joint posteriorly and passes to the middle toe. Sometimes it sends branches to the inner toe at other times, to the outer toe. Its tendon along the middle toe is never wanting and blends with that of the Peroneus medius.

FLEXOR PERFORATUS DIGITORUM.

Near its origin, this is quite a large muscle. It lies along the posterior face of the tibia and over the peroneus medius. It is fleshy above but soon divides into four parts. Two of these divisions pass to the second toe and the other two to the middle toe. These parts are subject to great variation.

PERONEUS MEDIUS.

This muscle arises along three-fourths the length of the tibia on its posterior face and from the posterior part of the distal end of the femur. It passes along the outer border of the posterior face of the tibia. Just above the tarsal joint, it becomes tendinous and passes trhough the canal at the proximal end of the tarso-metatarse, lies close along the posterior face of this bone, at the distal end of which, it divides into three branches, which pass to the three long toes.

MUSCLES OF THE BACK AND NECK.

In the domestic fowl, most of these muscles are not well developed. The most important ones are given and briefly described. With care, these can be dissected out and the points of origin and insertion examined. Since the neck is

long, muscles with several points of insertion are required. This want is supplied posteriorly by the *longus colli posticus et biventer cervicis* and anteriorly by the *longus colli*. To the action of these muscles, the many and graceful curves of the neck are due. Great variety and freedom of motion is given to the head, which performs the duties of both head and hand in mammals.

LONGUS COLLI POSTICUS ET BIVENTER CERVICIS.

These muscles arise in common from the spinous processes of the anterior dorsal vertebræ and extend along the back of the neck to the occipital bone. Eight or nine pairs are sent off along the course to be inserted into the vertebræ. The longest pair extends to the base of the skull and corresponds to the Biventer cervicis. It arises tendinous, then becomes fleshy, then again tendinous, then fleshy a second time, and finally inserts upon the occipital by a short tendon. The next longest pair inserts upon the sixth or seventh cervical vertebra. The shorter ones are subject to variation. By the action of these muscles the head and neck are thrown backwards.

SACROLUMBALIS.

It arises from the external half of the anterior margin of the ilium, from the fifth and sixth ribs, and from the transverse processes of the first dorsal and last cervical vertebræ. It extends np to the tenth or ninth cervical. The anterior portion of this muscle corresponds to the cervicalis ascendens or cervicalis descendens.

LONGISSIMUS DORSI

arises from the interior half of the anterior margin of the ilium and from the transverse and spinous processes of the last dorsal vertebræ. It lies along the depression between the consolidated spinous and the consolidated transverse processes. A tendon comes off from the ilium and runs along parallel with the spines, until it reaches the *spinalis dorsi*.

INTERSPINALES.

Since the spinal processes of the dorsal vertebræ are consolidated, these muscles are wanting in that region. In the cervical region they pass from the spinous process of one vertebra to that of the next.

INTERARTICULARES.

These short muscles pass from the oblique processes of one vertebra to those of the next.

LEVATOR COSTARUM.

They arise from the transverse process and insert into the anterior border of the following rib.

COMPLEXIUS.

Arises from the third, fourth and fifth cervical vertebræ, and inserts, one on each side, on the occipital bone, just external to the insertion of the biventer cervicis. If both of

the muscles act at the same time the head is thrown backwards; if only one acts the head is drawn to one side.

RECTI CAPITIS POSTICI.

These small muscles lie directly under the complexus. and act in the same manner as that muscle.

TRACHELO MASTOIDEUS.

This muscle arises from the first three or four cervical vertebræ, and insert upon the praoccipital. It turns the head to one side.

RECTUS CAPITIS LATERALIS.

Arises from the transverse processes of the fourth or fifth cervical vertebra and inserts upon the side of the basioccipital bone.

LONGUS COLLI.

This muscle corresponds in its origin and insertion to the longus colli posticus, and lies along the anterior or under aspect of the neck. It arises from the ventral faces of the anterior dorsal vertebræ, passes out between the clavicles, along up the neck, sending off branches which insert upon the vertebræ. The longest division extends to the atlas and inserts upon the small eminence on the under part of that bone. It is quite large where it passes out between the clavicles; but each of the branches is small like those of the longus colli posticus. It bends the neck.

RECTI CAPITIS ANTICI.

These muscles arise by many tendons from the same vertebræ upon which the preceding muscle inserts. These tendons unite, become fleshy and insert at the base of the skull.

CAUDAL MUSCLES.

Since the tail of birds is used as a rudder during flight, it becomes necessary that it be supplied with muscles which can raise, lower, or turn to right or left the "plough-share" bone which terminates the posterior extremity of the vertebral column. As the vertebræ of the caudal region resemblile those of the cervical in being freely movable upon one another; so do the muscles which produce these motions in the two regions resemble.

LEVATOR CAUDÆ.

This muscle arises from the upper and posterior part of the bones of the pelvis, and passes back along the caudal vertebræ, into the processes of which it inserts branches. A portion of the muscle inserts upon the base of the "ploughshare" bone. When the two muscles, one on each side, act together, the tail is raised; when only one acts at a time the tail is turned to one side.

ADDUCTOR CAUDÆ SUPERIOR ET INFERIOR.

These muscles are feebly developed in the fowl. The superior adductors arise from the posterior edge of the ischium, and insert upon the transverse processes of the caudal

vertebræ. The inferior adductors arise fro mthe tuberosity on the ischium and insert upon the same processes of the vertebræ. When all these muscles act together, they expand the tail, causing the feathers to stand out fan-shaped.

QUADRATUS COCCYGIS.

Arises from the transverse processes of the caudal vertebræ and inserts upon the shaft of the tail feathers. It separates and lifts these feathers.

DEPRESSOR CAUDÆ.

This muscle lies along the under side of the caudal vertebræ and is not so well developed as the levator caudæ. It arises from the lower face of the first vertebræ and inserts upon the inferior faces of the succeeding ones.