ERRATA.

Page 96, 19 lines from below, "unapophysial," to read "anapophysial."

Page 103, 16 lines from the top, "sacro-iline," to read "sacro-iliac."

Page 118, Fig. 5, under Plate II, to read: "Anterior view of sternum and first dorsal vertebra, with its corresponding vertebral and sternal ribs."

Page 119, 13 lines from the bottom, Fig. 22 refers to Fig. 21, which was not published.

Page 120, In the middle of the page, change lines to read: "this part of the skull rests upon the horizontal plane. To illustrate this in the skull we are studying, we find, when placed as directed above, that its equilibrium," etc.

Last page, Plate IV. To be added: "Fig. 46. Right femur posterior aspect.

Author's name to be corrected to read where it occurs: R. W. Shufeldt, First Lieutenant and Assistant Surgeon, U. S. A.

Compliments of the Author
Surgeon General's office
War Department
Washington D.C.
U. S Army

Art. IV.—Osteology of Speotyto Cunicularia var. Hypogæa.

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By R. W. Schufeldt, Acting Assistant Surgeon, U. S. Army.

In the United States we have but one species of Burrowing Owl, and this is a variety only of the bird found in South America. Our bird occurs on the prairies west of the Mississippi, notably in the villages of species of marmot squirrels, the deserted burrows of which it occupies for the purpose of nidification. Its behavior and habits are extremely unique and interesting. Perhaps no species in the great order to which it belongs have less limited power of flight, none so habitually congregate together in certain localities and choose the open, treeless country as their resort, and make their nests underground. So, in the study of the bony framework of this bird we may expect to find it modified to correspond with these habits, and presenting equal points of interest. Without further remark, then, upon its natural history, we will proceed to an examination of its skeleton. In enumerating and describing the separate bones, smaller sesamoids than the patellæ and the ossicula auditus (two of the latter bones being merely represented in cartilage) will not be taken into consideration. The latter are more properly treated in the study of the organ of hearing.

The skull.—As a general rule, it is only in the young of the Class *Aves* that the many bones of the skull can be separated from one another; the majority of the primitive segments of ossification of the four vertebræ that go to form this, the superior expansion of the vertebral column, being firmly anchylosed together, with their sutures completely obliterated when the bird has attained maturity. This is eminently the case in the adult skull of the species we have before us, so much so, in fact, that, with the exception of certain bones that remain permanently free during life, we will undertake to describe the skull only as it presents itself to us in the adult as a whole. In referring to certain points for examination, then, in this part of the skeleton, we will have to rely largely upon the reader's familiarity with general anatomy, the extent and position of the bones as they occur in the variously shaped heads of immature birds, and as to which of the two divisions of anthropotomists and some comparative anatomists, "bones of the cranium" and "bones of the face", they belong. The major part of the occipital lies in the horizontal plane, only that portion which originally constituted the superoccipital segment and the posterior third of the ex-

occipital segments curving rather abruptly upwards to meet the mastoids and parietals. All its primary parts are thoroughly coalesced, and its articulations with the surrounding bones obliterated, save a fine ridge, running transversely, just anterior to the condyle, separated from it by a depression which seems to indicate the remains of the occipito-basi-sphenoidal suture. Posterior to the foramen magnum the bone rises and displays a well-marked "cerebellar prominence", with a depression on either side of it. On the summit of this prominence, in the median line, just before we arrive at the foramen magnum, we find the supra-occipital foramen. This foramen varies in size and shape in different individuals—in size, from one to two millimetres; in shape, from a circle to a transverse ellipse, though it is usually small and circular. It is said to be formed by a thinning of the bone due to muscular pressure from without and the pressure of the cerebellum from within; in the fresh specimen it is covered by a thin membrane. Lying in the horizontal plane, anterior to the cerebellar prominence, is the foramen magnum. In shape it resembles a square with the four angles rounded off. Its average measurement is five millimetres transversely and four millimetres antero-posteriorly, the latter diameter being encroached upon by the occipital condyle in the median line. The occipital condyle is sessile, though raised above the level of the basis cranii, hemispheroidal in form, with a minute notch marking it posteriorly in the middle. Immediately beyond the condyle appears a depression, on either side of which are seen the precondyloid foramina for the transmission of the hypoglossal nerves; they are extremely small, and open anteriorly. External to these, lying in the same line transversely, is seen a group of usually three foramina for the passage of the eighth nerve and the internal jugular vein. The lateral terminations of the occipital, the paroccipital processes, are large, thin, pointed forwards, and on a lower level than the rest of the bone, forming a large part of the floor of the tympanic cavity. The semi-elliptical contour of the cranium, regarding it from a basal view, is well carried out laterally by the wing-like and attenuated mastoids. They contribute largely to the formation of the walls of the tympanic cavity internally, and externally assist in some degree towards completing the temporal fossæ. These fossæ are deep; commencing posteriorly on either side at the external borders of the depressions already mentioned that bound the cerebellar prominence laterally, they take a course upwards and outwards, terminating at a foramen that lies just within the posterior periphery of the orbit, which foramen allows the passage of the tendon of the temporal muscle. From the upper boundary of the temporal fossæ to where the frontals suddenly abut against and even overhang, to some extent, the nasals, the external and superior surface of the skull is of a pearly whiteness and very smooth in the dry skeleton, presenting not a trace of the sutures between the bones that go to form it, the frontals and parietals. This surface is divided by a well-marked furrow, that extends in the median line between the

cerebellar prominence and the upper mandible. It is deepest in the parietal region. Close inspection of this area reveals minute ramifying grooves for the lodgment of vessels, one set running in the direction of the temporal fossæ and another towards the orbits. In the "bird of the year" the skull-cap is very thin and brittle in the dry condition; but a very different state of affairs presents itself when we remove a section of the cranial vault from above, in the adult, where the skeleton is full-grown, such as we have before us. We find exposed to our view one of the common characteristics of the family; the two tables are light, thin, but compact, with a goodly supply of diploic tissue between them, attaining a thickness in some localities, notably above the exit of the olfactories, of two millimetres or more. Owing to the large orbital cavities, the brain-case is crowded to the rear to such an extent that the fossæ for the cerebral hemispheres are situated immediately over the cavities intended for the other encephalic lobes. We find the internal opening of the foramina, already described, at the base of the brain. The *petrosals* have the appearance of two white leaves, harder than the surrounding bone, slightly turned upon themselves, with their stems leading towards the fossa for the hypophysis. They present for examination the openings for the portio dura and portio mollis, the former foramen being on a lower level and anterior to the latter. In the median line running from the cerebellar fossa to the exit of the first pair of nerves along the roof is a raised crest, grooved on its summit for the longitudinal sinus. It sinks for a little distance, in the fresh specimen, into the cerebral interspace. The "sella turcica" is deep, its long axis being perpendicular to a plane passing through the foramen magnum. It has at its base the openings for the carotids. Immediately beyond its anterior superior border is seen the niche, with its foramen at either end, for the passage of the optic nerves and lodgment for the optic chiasma. Above the optic foramina, situated still more anteriorly, is a conical pocket, pointing forwards and a little upwards, with the olfactory foramina at its apex, two in number, giving passage for the nerves to the orbits. The *basi-sphenoid* is thoroughly united with all the bones it comes in contact with, except the pterygoids, palatines, and tympanics. Its anterior process—the basi-presphenoid—loses itself with the vomer in the interorbital septem, not a trace remaining of the original margins of the two bones. Its wings, the orbits, and the ali-sphenoids share the same fate with the bones that surround them. They form the larger part of the posterior wall of the orbital cavities. With the body of the bone the ali-sphenoids assist in closing in the tympanic cavities. The "pterapophysial" processes of the basi-sphenoid are present; they are short, thick, and elliptical on section, crowned by facets of the same figure at their distal extremities, which look downwards, forwards, and outwards, articulating with a similar facet at the middle, third, and posterior border of each pterygoid. The bone also presents for examination the usual nervous and arterial foramina and grooves for the Eustachian tubes, the foramina being particu-

larly worthy of notice on account of their marked individuality, all of them being distinct and nearly circular. The *tympanics* are free bones, and carry out all the usual functions assigned to them. The mastoid condyle is long, affording by its extension an additional margin at the under side at the end of the bone for attachment of the ear-drum; the neck between it and the orbital process is somewhat constricted, and presents a large pneumatic foramen on the inner surface. The pointed orbital processes extend upwards, forwards, and inwards, slightly clubbed at their extremities; they project into the space half-way between the pterygoid and wing-like post-frontal. The mandibular condyle is double; the inner one is a semi-ellipsoid, placed transversely; the outer an irregular figure, and separated from the inner by a shallow pit. The oval, cup-shaped cavity for the reception of the tympanic extremity of the squamosal looks directly forward. Between the orbital process and inner mandibular condyle, on the free edge of the bone, is seen a small articular surface for the tympanic extremity of the pterygoid. The *pterygoids* diverge from each other towards the tympanics by a very open obtuse angle. They are slender and scale-like, being compressed from above downwards, twisted on themselves at their tympanic extremities, causing the long axis of the articular facets for the articulation with these bones to be vertical. As already described, they have a mid-posterior facet, which meets the pterapophysial process of the basi-sphenoid. Anteriorly they do not touch each other, but articulate with the extremities of the palatines, and the combined four bones touch, and in the living bird glide over for a limited distance the lower border of the rostrum of the basi-presphenoid. The anterior ends of the *palatines* articulate by an anchylosed schindylesial articulation between the lower surfaces of the maxillaries and the thin upper surface of a bony process extending backwards from the intermaxillary. From this point they slightly diverge from each other and become broader, being broadest about their middles; they then rather abruptly approach each other posteriorly, where they form the joint with the pterygoids already described. Their posterior ends are kept slightly apart by the lower border of the presphenoid. They are flattened from above downwards throughout their entire extent. Their outer borders are sharp, and form from one end to the other a long convexity. As the inner and concave borders approach each other posteriorly they develop a raised rim on their under sides, thereby affording a greater surface for muscular attachment. Above, near their middles, they aid the maxillaries (and in large part developed from them) in supporting on either side an irregular spongy bone, that serves the double purpose of narrowing the apertures of the posterior nares and adding bony surface to the roof of the mouth by constriction of the palatine fissure. As is the rule in nearly all birds, the tympanic end of the *infraorbital bar* is on a lower level than the maxillary extremity; it is received into the cup-like articulating cavity on that bone. The two oblique sutures, persistent in many birds, and denoting

the original division of this bony style into three separate bones, the maxillary, malar, and squamosal, are here entirely effaced. As a whole, it is compressed from side to side, and of ample size in comparison with other bones of the head. At about the locality of the malo-zymotic suture the bone throws upwards a thin expansion that meets the descending postfrontal, thus completing the orbital circumference at that point. Its anterior and fixed extremity is made up by the maxillary. Here it forms externally a portion of the posterior surface of the bill, while internally it assists in forming the roof of the mouth and floor of the nasal cavities, and otherwise behaves as already described. The *lachrymals* are extremely spongy in texture, covered by an outside delicate, compact bony casing. They articulate above by a ginglymoid joint with the posterior border of the nasals, resting below on the spongy bones developed from the superior surfaces of the maxillaries. They are limited to a slight movement inwards and outwards, and aid in separating the orbital cavities from the rhinal chamber. Externally they present for examination a shallow groove traversing the bone obliquely downwards and forwards and a little inwards for the lachrymal duct. The orbital cavities are very large, and remarkable for the completeness of their bony walls and the near approach their peripheries make to the circle, any diameter of which measures the merest trifle above or below two centimetres. The septum in the adult bird has rarely more than one small deficiency of bone in it. This usually occurs in about the position shown in Pl. I. The sutures among the various bones have entirely disappeared, nothing being left to define the exact outline of the vomer especially. The groove for the passage of the olfactory nerves forward is well marked, the cranial foramina for them being distinct, one in each orbital cavity. This also applies to the openings for the optic nerves. The extent of the roof is increased on either side by a superorbital process (shown in Pl. II, Fig. 1) that points downwards, backwards, and outwards, and serves for membranous attachment. The posterior walls are marked by ramifying grooves for vessels. They have a direct forward aspect, which is enhanced by the low descent of the broad and thin postfrontals. Anteriorly, the aperture between these and the rhinal vacuities is diminished by the lachrymals externally and by a wing-like plate thrown off from the prefrontal internally. This latter bone here terminates in a sharp concave border, with a descending ridge on either side just within it. The floors of the orbits are more complete than is usually seen in the class, due to the flatness and position held by the pterygoids and palatines, the wing-like process of the ethmoid just referred to, and the pterapophysial processes of the basi-sphenoid. The *sclerotals* number from fifteen to sixteen, all of them being about the same length, but varying as to their width; in figure they are trapezoidal and universally oblong, with the short parallel side in the circumference of the cornea and the opposite one resting in the periphery of the posterior hemisphere. We have never observed one that was wide enough to appear square.

They are rather thin, concave outwards, very slightly movable at their opposed edges, and carry out their usual function of maintaining the form of the optical apparatus. The orbital periphery very nearly fulfills that rare condition in birds of a complete bony circuit. It is only deficient at the point where the lachrymal fails to touch the maxillary. The *upper mandible* of this bird is made the more conspicuous and distinct from the remainder of the skull by the abrupt way in which it is attached and the much firmer texture of the bone. The mandibular culmen is perfectly convex from the tip of the sharp-pointed extremity to where it suddenly terminates under the slightly overhanging frontals, or, more correctly, the minute surface appearance of the prefontal, for although it is not evident in the adult that that bone makes itself visible at this point, yet it may be demonstrated in skulls of younger specimens. The culmen, as in other birds, is formed by the intermaxillary, which is here firmly united with the nasals, and the two in conjunction form the peripheries of the truly elliptical external nasal apertures or nostrils, the first bone bounding them anteriorly, while the latter completes their arcs in the rear. These in the dry skull measure through their major axes seven millimetres, and through their minor ones barely five millimetres. They have a distinct ring raised around their circumference, which is wanting, however, where they nearest approach each other anteriorly at the culmen. The plane of the nostril faces upwards, outwards, and forwards; the nostrils are completely separated from one another by a vertical bony septum, developed from the intermaxillary, not a common occurrence in birds. They have, in addition, a concave bony floor, that rises behind into a posterior wall, leaving really two semicircular openings just beneath the culmen, separated from each other by the vertical septum. The osseous mandibular tomium, also a part of the intermaxillary, is as sharp as when the bill is sheathed in its horny integument. The arc is concave, and falls off rapidly as it approaches the tip of the beak. Occasionally, in very old birds, the *ethmo-turbinal* bones in the nasal passages may ossify. The *nasals* form here the sides of the bill, and are firmly anchylosed to the bones they meet, except the lachrymals. The movability of the fronto-mandibular articulation is limited. The dry skull is extremely light and brittle, giving one the sensation in handling it that he might experience while examining an egg from which the contents had been removed. A line drawn from the tip of the upper mandible to the outermost point of one tympanic, around the arc of the cranium to a similar point on the opposite side, and back to the point of departure, describes nearly the sector of a circle. The longest radius, which is in the median line, measures four and one-half centimetres, the chord between the tympanics about three centimetres.

The hyoid arch.—The hyoid arch is suspended from the base of the skull by its usual attachments. In this Owl it consists of but six very delicate little bones, involving five articulations. The tips of the up-

turned posterior extremities are about opposite the lower borders of the temporal fossæ, its two limbs diverging from each other at an angle equal to that made by the lower mandible. The cerato-hyals are rather large in comparison with the other bones. They are joined both anteriorly and posteriorly by bony bridges, forming a fenestra between them, to be filled in by a thin membrane. The amount of divergence they make from each other is less than that made by the hypo-branchial elements of the thyro-hyals. Anteriorly, the bone connecting them supports a cartilaginous glosso-hyal, while the posterior connection presents for examination the usual smooth articulating surface that enters into the arthrodial joint it makes with the basi-hyal. The basi-hyal and uro-hyal are confluent, not a sign of the point of union remaining. The latter bone is continued a short distance posteriorly by a tip of cartilage. The anterior end of the basi-hyal is devoted to the articular surface for the bone connecting the cerato-hyals, forming the joint mentioned above. It is concave from above downwards, convex from side to side, the lower lip being the longer. It will be plainly seen that this combination grants to the tongue a movement in the vertical and horizontal planes. The anterior articulating heads of the hypo-branchial elements of the thyro-hyals are opposite each other, each being received into the diminutive acetabulum intended for it at the side of the united basi and uro-hyals, and most probably at the junction of the two latter bones. These two elements are long bones having a cylindrical shaft, terminating at either end in an articulating head. They are the longest bones in the hyoid arch, and have a gentle curvature upwards throughout their extent. The inner heads form an arthrodial joint on either side with the outer heads of the cerato-branchial elements of the thyro-hyals. These, the last bones of the arch, are joined in the manner already shown above. Their inner ends are quite pointed, even as far as the bone goes, the extreme points being finished off with cartilage. They curve upwards from about their middle thirds, and, like the first elements of the thyro-hyals, they are long bones, but with curved cylindrical shafts, the outer end, however, being the only true articulating one.

The lower mandible—(Pls. I and II, Fig. 3.).—That portion of the bone which originally was separate as the dentary element, and as far back as to include the interangular vacuity, is firm and compact, while the remainder has much the same character as the bones of the cranium, being cellular and light, having only a very thin outside layer of the harder tissue. All of the primary segments are firmly knitted together, the only sutural trace to mark the margins of any one of them being the posterior border of the dentary elements as they bound the fenestra before and slope away beneath it. The articular extremities are some little distance below the upper outline of the bone. Their superior surfaces are indented so as to accurately receive the condyles of the tympanics on either side, forming the joint that allows the opening and closing of the mandibles. Their under surfaces are smooth and rounded, having a

fine ridge running across them transversely. Internally they are drawn out gradually into subcylindrical processes that point upwards, inwards, and a little forwards, exhibiting superiorly on each, about the middle, an oval pneumatic foramen. The upper edge rises rather abruptly from the articular ends, presenting as it arrives near the general level a rudimentary coronoid for the insertion of the tendon of the temporal. With the exception of a little elevation where the dentary element meets the surangular, the superior outline is unbroken; it falls away rapidly as it approaches the symphysis, where, with the opposite border, it completes a little notch at the extremity. The tomium is not as sharp as in the upper bill, and the mandibles do not fit nicely to each other until covered with their horny sheaths. The inferior border is rounded throughout its extent, and on a level at its posterior commencement with the under surfaces of the articular ends and running nearly parallel with the superior. The curve described by the rami before they meet at the symphysis inferiorly approaches the parabola in outline. The sides of the jaw are nearly smooth internally and externally. The vacuity that occurs in so many birds at the junction of the middle and inner thirds is rather large, long, and spindle-shaped, and filled in, in the fresh state, by an attenuated membrane.

The spinal column; cervical portion.—There are fourteen cervical vertebræ, each one having a more or less free movement with the one beyond and behind it, maintaining in all positions some variation of the usual sigmoid curve observable in the division of the vertebral column throughout the class. The arrangement, as well as the direction, of the planes of the zygapophysial articular surfaces allow considerable rotary movement in the vertical plane, with combinations of the two. It is a common habit of this bird, among other of his antics, to duck his head smartly downwards and again upwards, several times in succession, upon being approached. The relative position of the cervicals has been figured in Plate I from the dead bird, placed in the act of this particular manœuvre, in a specimen after careful dissection. The calibre, as well as shape, of the neural canal in this portion of the spinal column varies at different points. It originates at the atlas as a transverse ellipse, with a major axis of four millimetres and a minor axis of a little less than three millimetres; this is about the maximum capacity throughout the entire canal. From the atlas to the sixth or seventh vertebra the ellipse gradually approaches the circle, with a marked diminution in size, its diameters being at the seventh about two millimetres in any direction. From this point to the twelfth, inclusive, it rises as it fell, from the atlas, and in the same manner, when we again discover a transverse ellipse, perhaps a jot smaller than the one described in speaking of the atlas. In the thirteenth the canal is smaller than, though in all other respects resembles, the twelfth, but an abrupt change takes place in shape as we pass to the fourteenth or last cervical, where the form of the neural tube suddenly approximates the cir-

cularity of the dorsal vertebræ. The vertebral canal begins, circular, on either side at the third cervical vertebra, most of its length being immediately beneath the prezygapophyses of each segment. It is formed in the usual manner by the di- and par-apophysial processes uniting laterally with the pleurapophysial elements. Small at the cephalic extremity of the column, its calibre gradually increases in each vertebra as we proceed toward the thoracic extremity, until it attains its maximum capacity at the eleventh vertebra. In the twelfth the integrity of its walls is lost by a parting of the par- and pleur-apophysial elements, with a disappearance of the former, leaving it no floor, so that in this vertebra it ceases to be a closed canal. The most prominent object presenting itself for examination in the atlas, superiorly, is the deep reniform cavity for articulation with the occipital condyle of the basi-cranii. It makes up to the entire superior articulating surface of what would first appear to be the centrum of this vertebra, unless we should not consider such to be the case until the odontoid process of the vertebra next below, the true centrum of the atlas, lends its assistance, in which event the surface of this articulation is only complete when made so by the extremity of the process just alluded to. A membrane, however, always stretches across this interspace, separating the extremity of the odontoid from the condyle of the occiput. This is not invariably the case, either, as in many of the individuals we have examined a minute vacuity usually exists, allowing the process to come in immediate contact with the condyle at one point. Below and posteriorly there is another articulating surface, convex for the centrum of the axis and concave for its odontoid process, accurately meeting the opposed surface of this vertebra and forming the atlo-axoid articulation. A lip of bone, a portion of the hypapophysis of the vertebra we are now describing, projects downwards and shields this joint in front, overlapping, indeed, a good part of the axis. The neurapophyses of the atlas are slight in structure. The concave postzygapophyses articulate with the convex prezygapophyses of the axis. The bone is devoid of a neural spine. In the axis we find both an hypapophysis and neural spine developed, the former being produced from the ridge on the anterior aspect of the centrum of the bone. The odontoid process arises vertically from the posterior margin of the upper surface of the centrum. Its summit and anterior face are convex and articulating, while behind it is flat and continuous with the spinal canal. The facet for articulation with the centrum of the third vertebra looks downwards and inwards, is convex from side to side and concave in the opposite direction. The postzygapophyses are concave, look downwards and outwards, the conditions in the prezygapophyses being exactly the opposite; this is the rule throughout the cervical portion of the column. After we pass the atlas and axis, we find in the third cervical vertebra here, as in most vertebrates, parts that are common to the series of this portion of the column, deviating but slightly from each other as we examine them

in seriation; but gradually as this deviation proceeds, some requisite condition is brought about when the climax is attained. The fact of the presence of a neural spine on the axis is conveyed, though in a less marked degree, to the third or next vertebra below, where it occupies a position about in the middle of the bone. As we descend, this process becomes less and less prominent, being found set further back on each successive vertebra; it disappears about entirely at the tenth, after which it rapidly begins to make its appearance again, assuming its former position in the middle of the vertebra, being quite evident in the twelfth in the shape of a pointed spine, while in the fourteenth it bears the quadrate form, with extended crest, being the first step towards an assumption of that notorious feature found further on in the dorsals. In the third vertebra the space between the pre- and post-zygapophyses is almost entirely filled in, a minute foramen on either side alone remaining, by a lamina of bone extending from one process to the other, giving to this vertebra a much more solid appearance, which in reality it possesses above that attained by any of its fellows. This bony lamina is reduced in the fourth vertebra to a mere "interzygapophysial bar" connecting the processes, while in the next succeeding one or two vertebræ it occurs only on the prezygapophyses more as a tubercle, being directed backwards, then disappearing entirely, is to be found again only on a few of the last cervicals as an ill-defined knob, still retaining its original position. The diapophyses at first project nearly at right angles from their respective centra, then approach the median line by being directed more backward near the centre of the cervical division of the column, and on nearing the dorsals again gradually protrude more and more directly outward. The prezygapophyses of the ninth cervical support well-marked unapophysial tubercles, which are feebly developed also on a vertebra or two both above and below the ninth. The joints between the bodies of the cervicals of this Owl are upon the same plan as those found throughout the class; the anterior facet being concave from side to side, convex from above downwards, the reverse being the case with the posterior facets, and when articulated fitting accurately into each other. The pleurapophysial elements, well-marked in all the cervicals after passing the axis, become in the thirteenth vertebra a free cervical rib, about three millimetres in length, without neck or true head, being merely suspended on either side from the diapophysis of the vertebra, and freely movable on its exceedingly minute articulating facet.

Attached to the last cervical we find the second pair of free pleurapophyses, about two-thirds as long as the first pair of dorsals or true ribs of the thorax, terminating in pointed extremities and articulating with the vertebra by both capitula and tubercula, the former on elliptical facets, placed vertically on either side of the centrum at the anterior margin of the neural canal, and the latter on rounded facets beneath the diapophyses. The tubercle on one of these ribs is nearly as long as

the neck; at the junction on the posterior side is found a pneumatic foramen of considerable size. These ribs are more or less flattened above, from before backwards being convex anteriorly, concave posteriorly, becoming rounded below. From the third to the ninth vertebra, inclusive, appear beneath the vertebral canal anteriorly well-developed styliform parapophysial processes, directed backwards and downwards. They are best marked on the segments of the middle of the neck. There is no instance in this bird of these processes being produced so far backwards as to touch the next vertebra below; their tips, as a rule, about overhanging the middle of the centrum of the vertebra to which they belong. We have found in specimens of *Bubo virginianus* the parapophyses of the fourth vertebra overlapping and touching the fifth for a millimetre or more. The third and fourth cervicals have, beneath in the median line posteriorly, strongly developed hypapophyses, quadrate in form, a process that exhibits itself on the fifth vertebra, anteriorly, merely as a small tubercle. On the sixth this tubercle has disappeared, and has been supplanted by two others that are now found just within the periphery of the anterior facet of the centrum on the parapophysis of each side, beneath and inclined toward each other. These processes, now a double hypapophysis apparently developed from the parapophyses, continue to increase in size and inclination towards each other on the next three vertebræ, so that on the ninth, where they last appear, they nearly form a closed canal. The passage between them is intended for the carotids, to which they afford protection. The hypapophysis of the tenth, eleventh, and twelfth vertebræ is single, large, quadrate, and directed forwards and downwards. There are three on each of the last two vertebræ, each having an independent root, the two lateral ones directed downwards, forwards, and outwards, with characteristics similar to the one in the median line. Several pneumatic and nutrient foramina perforate each cervical vertebra at various points, except in the axis and atlas, where, after diligent search, aided by the lens, we have signally failed to discover them.

Dorsal vertebræ; vertebral and sternal ribs; sternum.—The dorsal vertebræ number five; the anterior one articulates with the last cervical and the last dorsal with the first sacral. Although the dorsals of this bird fit very snugly to each other, it requires no further masceration to separate them from one another than it does to remove the ribs from their attachments. This close interlocking, however, greatly diminishes the movement of this division of the spinal column, bestowing upon it a rigidity only exceeded by the anchylosed vertebræ of the sacrum; yet, it must be understood, they do enjoy, in this Owl, a considerable degree of movement, especially laterally. The neural spines have here attained their maximum development, forming, when taken together, an elevated and compressed median crest, with a thickened summit, and having a firm hold upon the remainder of the vertebræ below. Taken separately, the last is the smallest, the fourth next, the first next, and the second

and third the largest. Their anterior and posterior borders are concave, allowing, when articulated, spindle-shaped apertures to exist among them, while their summits are produced backwards and forwards, thickened, and wedged into each other. This wedging is performed in the following manner: The posterior extremity of the crest forming the summit of the neural spine of the first dorsal divides and receives the anterior extremity of the crest of the second. This same arrangement exists between the second and third, and at the summit between the third and fourth, but the fourth immediately below the junction also divides for a little distance and receives the edge of the posterior rim of the third, just beneath the union of the crests. This latter method of joining is feebly attempted between the fourth and last. (See Pl. I.) The neural canal is nearly cylindrical in the dorsal region, its calibre being less at the sacral extremity, and rather compressed from side to side, as are the centra as we approach that end, each one being a little more so than its neighbor beyond. Viewing these five vertebræ from above in the articulated skeleton, we observe the spinous crest already described; we are struck with the regularity with which the postzygapophyses overlap and adjust themselves to the prezygapophyses from before backwards, like the scales in some fishes, the facets of the former facing downwards and outwards, the opposed surfaces of the latter facing upwards and inwards. The neurapophyses are horizontally compressed and rather broad; the diapophyses jut from them at right angles from points about their middles. There is an inclination for the latter to be directed slightly backwards as we near the sacrum. The diapophysis of the first dorsal is the shortest and stoutest, that of the last the most delicately constructed. Superiorly, these processes support metapophysial ridges at their extreme outer borders. These ridges on the diapophyses of the first dorsal are the largest, rounded at both ends, extending a little both backwards and forwards, but far from touching the ridge either in front or behind them. The metapophysials of the last dorsal are smaller, sharp, styliform, and project only forwards, though they do not by any means touch the diapophyses in front of them. On the intermediate vertebra they change gradually between these two extremes, but in no instance meet the diapophyses of the vertebra before or behind them, and thus constitute an additional aid to the rigidity of the back, as it does in other species of this family and in many other birds. The centra increase in depth beneath the neural canal the nearer they are to the sacrum. In the first dorsal the body measures about one millimetre, the vertical diameter of the canal being three; in the last dorsal it equals the diameter of the canal. The interarticular facets are in the vertical plane, with their concavities and convexities opposed to each other, as they were described when speaking of the last cervical vertebræ. The bodies are about of a length, constricted at their middles and expanding towards their extremities. The first two dorsals each bear in the median line, beneath, an hypapophysial process of consider-

able size, affording abundant surface for attachment of some of the muscles of the neck. The process of the first dorsal has one common trunk, with a compressed midprong and two lateral and pointed subprocesses. (See Pl. II, Fig. 5.) The second dorsal possesses a single long hypapophysis, quadrate in form, dipping into the chest further than the first. There is not a trace on the remaining dorsals of this appendix. Parapophysial processes, so prominent in nearly all the cervicals, afford in the dorsal vertebræ simply articulating facets for the capitula of the pleurapophyses situated just within the anterior margin of the neural canal of each centrum, never extending to the vertebræ beyond, forming the demi-facet of andranatomia. Immediately above these facets, on either side, may be noticed a group of pneumatic foramina of various sizes and shapes, and again, anterior to these foramina, the rim of the body of the vertebra for a limited distance becomes sharply concave, being opposite to a like concavity in the next vertebra, the two, when opposed and articulated, forming the oval foramen for the exit of the dorsal nerves. Elliptical articulating facets for the tubercula of the pleurapophyses, looking downwards and outwards, are seen on the inferior ends of the diapophyses, with a midridge running from each facet to the base of the process, to be expanded and lost on the sides of the centra. As there are five dorsal vertebræ, so are there five *pleurapophyses* articulating with them and with the hæmapophyses below. Each rib is attached to a single vertebra, as shown while speaking of the dorsals. The necks of these ribs become more elongated the nearer they are to the pelvic extremity of the body, the first possessing the shortest. This is exactly reversed in regard to the pedicles bearing the tubercula, being the longest in the first pleurapophysis and shortest in the last. This contraction of the pedicles is progressively compensated for by the lengthening of the corresponding and respective diapophyses of the vertebra to which they belong. Viewing the ribs from the front, in the skeleton, the curve they present resembles the quadrant of a shortened ellipse, the vertex of the major axis being situated at the base of the neural spines; viewed laterally, the curve is sigmoidal, though a much elongated and shallow one, with the hæmapophysial extremity looking forwards and the facet of the tubercle backwards. The first rib is the shortest and generally, though not always, the broadest; the last being the longest and most slender, the intermediate ones regularly increasing in length and diminishing in breadth from the first to the last. In form, the ribs of this Owl are flattened from side to side, widest in the upper thirds, narrowest at their middles, and club-shaped at their lower extremities, where they articulate with the sternal ribs by shallow facets. On the inner surfaces we find the necks produced upon the bodies as ridges, running near their anterior margins and becoming lost at about the junction of the upper and middle thirds in the body of the rib. Pneumatic foramina, from two to three in number and of considerable size, are found just within the commissure between neck and tubercle, posteriorly. All the verte-

bral ribs bear a movably articulated epipleural appendage, each resting in a shallow cavity designed for it upon the posterior borders. They leave the rib at right angles, but soon turn upward with a varying abruptness. The appendage of the first rib is situated lowest of any on its rib, that of the last the highest; the facets of the others are found in the line joining those of the first and last. They all make acute angles with the bodies of the ribs to which each belong, above their points of insertion. The angle made by the last is the least, and it increases to the last. The epipleurals of the leading pleurapophyses are the widest and generally the longest (the one on the second rib in a skeleton of this bird now before me is as wide as the rib at the point from where it starts), the one on the last rib being always the smallest.

Clubbed at their superior extremities, each one overlaps the rib behind it, and in this manner add stability to the thoracic parietes, which is undoubtedly the function these little scale-like bones were intended to fulfil. The *hæmpapohyses* connect the vertebral ribs with the sternum. There are six of them, one articulating with each vertebral rib and having a concave facet to receive it, while the last meets the sacral rib above and articulates with the posterior border of the fifth below. The first one is the shortest and most slender of all; the fifth is the longest. With the exception of the last, their superior ends are enlarged and compressed from side to side, while below their middles they become smaller; then turning upon themselves, suddenly enlarge again, so as to be flattened from before backwards, when each terminates by a transverse articular facet for articulation with the hæmal spine. Quite an interspace exists between their points of contact with the sternum. They all make a gentle curve upwards just before meeting their respective ribs. The hæmapophysis that articulates with the sacral rib is inserted in a long, shallow groove on the posterior border of the sternal rib that articulates with the last dorsal pleurapophysis, but does not meet the sternum—simply terminating in a fine point on the posterior border of the sternal rib mentioned. From before backwards the sternal ribs make a gradually decreasing obtuse angle with the vertebral ribs, while the angle they make with the sternum is a gradually increasing acute from the fifth to the first. On the anterior surfaces of their expanded sternal ends are to be found on each a minute pneumatic foramen or two. The anterior third of the lateral borders of the sternum is the space allotted for the insertion of these bones.

The Burrowing Owl being a bird not possessed of any considerable power of flight, a circumstance arising from the life it was destined to lead, or the necessity of having that flight ever long sustained, we would naturally expect to find, in the course of a study of its anatomy, those characteristic modifications of the various systems which pertain to species of the class in which that gift has always been a secondary consideration. Nor are we disappointed in this expectation, for a single glance at the size of the sternum of this Owl, when compared with the

remainder of its skeleton with regard to areas for muscular attachments, reveals to us the disproportion of the surface supplied by that bone for the attachment of the pectorals. That its dimensions are relatively contracted is proved by actual, comparative, and proportional measurements of the bones with other species of its family, individuals of which, at the best, are not noted for their powers of flight as a rule, and consequently the hæmal spine does not present so prominent a feature of the skeleton as it does in other species of the Class *Aves* where vigorous flight is habitual. Life-size figures of this bone, viewed from the three principal positions for the purpose of study and measurement, are offered to the reader in Pl. I and Pl. II, Figs 5 and 6. The concave dorsal aspect of the body is smooth, being traversed in the median line by a very shallow groove that lies immediately over the base of the keel. This groove terminates, within five millimeters of the anterior border, in a little depression, at the bottom of which are discovered pneumatic foramina, two or more in number, leading to the anterior thickened vertical ridge of the carina beneath. Other minute openings for the admission of air into the interior of this bone are seen among some shallow depressions just within the costal borders. The bone does not seem to be as well supplied in this respect as it is in some other Owls. The costal borders supporting the transverse articular facets for articulation with the hæmapophyses occupy about one-third of the entire lateral border on either side anteriorly. At the bases of the majority of the depressions that occur between these facets are found other pneumatic foramina. The anterior border is smooth and rounded, with a median shallow concavity occupying its middle third. At its extremities, laterally, the costal processes arise with a general forward tendency at first, but with their superior moities directed backwards. The costal borders terminate at the posterior borders of these processes, at a higher level than the anterior sternal margin does at their anterior borders. The coracoid grooves are just below the anterior border. They are deep, continuous with each other, having a greater depth behind the manubrium in the median line than observed at any other point. Their general surface is smooth and polished, looking upwards and forwards, and lying principally in the horizontal plane. They melt away into the body of the bone laterally, at points opposite and not far distant from the posterior articulations on the costal borders. The margin that bounds them below is sharp, travels at right angles from the median line at first to a point posterior to the costal processes, then making a little dip downwards, then again curving upwards, disappears gradually with the groove it bounds. That portion of it from the point where it changes its direction to its termination is described by authors as the subcostal ridge. The manubrium, occupying its usual position in the middle line, is comparatively small, quadrate in form, compressed below, slightly notched and flattened above, its posterior surface forming the inner anterior surface of the coracoidal groove. All the borders bound-

ing the posterior parts of the bone are sharp; the lateral one, taken from the apices of the costal processes to their other and lower terminations, are concave. As is the arrangement generally among Owls, the xiphoidal extremity of the sternum is four-notched, two on either side, the outer notches being the deeper. Both have rounded bases, and the processes that separate them are ample and possess rounded extremities. The border upon which the keel ends posteriorly is square, though we have met with specimens in which it was slightly notched in the median line. The body is oblong, and, if we include the xiphoidal processes on either side, has a length half as long again as its width. The ventral and convex surface, like the dorsal, is smooth and presents but two points for examination. The pectoral ridge, faintly marked throughout its extent, originates on each side at a point near the outer borders of the coracoid grooves, running inwards and backwards, and dies away at the base of the keel near its middle. This little ridge denotes the line between the pectoralis major and minor. The keel is moderately well developed, the distance from the base of the manubrium to the carinal angle being equal to the distance from the same point at the base of the manubrium to the base of either costal process or outer anterior sternal angle. It is compressed, smooth, and thin, but its stability is greatly aided by the carinal ridge on either side, which commences strong and well marked at the base of the manubrium, just within the anterior border running parallel with the latter, and disappears as it approaches the carinal angle. The anterior border of the keel is sharp and concave; the inferior border is convex, with the edge slightly thickened. The point of intersection of these two borders anteriorly is rounded and forms the carinal angle. The inferior border expands posteriorly, and the keel terminating a short distance before arriving at the posterior sternal border, the two become blended with the surface of the body of the bone.

Sacral vertebræ; pelvis; and coccygeal vertebræ.—It is no uncommon occurrence to find in the skeletons in many species of birds at least one or more of the anterior sacral vertebræ articulating with a greater or less amount of freedom with one another, but in the sacrum of the Owl now under consideration, with the exception of a few faint lines indicating the original individuality of the vertebræ, the bones are thoroughly anchylosed together and to the ossa innominata. From inspection of this compound bone in immature birds, we find the usual number of sacral vertebræ composing the sacrum to be thirteen. The anterior face of the first possesses all the necessary elements for articulation with the last dorsal. The neural spine has a thickened crest that soon meets the ilia on either side; its anterior edge is thin, and gives attachment below to the interspinous ligament. The neural canal is circular, and the prezygapophyses well marked. The articular facet of the centrum is in the vertical plane, with its curvatures similar to those ascribed to the anterior facet on the centra of the dorsals. The neurapophyses are broad

and the diapophyses are strong and raised, with their enlarged extremities expanded upon and firmly united with the iliac bones. There is but one pair of sacral pleurapophyses, and they are free ones. Long and slender, they articulate with the first vertebra in the usual manner, but the relation is much more intimate, as they touch the diapophyses for some little distance beyond the tubercula towards the capitula. The lower extremities of these ribs are terminated by little roundish knobs, which articulate with the hæmapophysis on either side, described as being inserted in the posterior border of the fifth sternal rib. Viewing the bone dorsal-wise, it is to be seen that the thickened crest of the neural spine of the first vertebra protrudes from the angle made by the ilia meeting it anteriorly to a greater or less distance. This broad and compressed crest, then continued backwards, is firmly wedged between the ilia until we pass the third vertebra; at this point the ilia diverge from each other to another point just anterior to the acetabula, then converge, terminating in the posterior sacro-iline border within five or six millimetres of each other. The sacrum completely fills in the lozenge-shaped space thus formed from the third vertebra—first, by continued broadening and compression of the neural spine, that soon becomes one with the neurapophyses; and, secondly, by the expanded extremities of the di- and par-apophyses, the processes themselves also taking due part. The integrity of the surface is unbroken, save posteriorly, where a few pairs of foramina exist among the expanded transverse processes, increasing in size from before backwards. Anterior to a line joining the acetabula this surface is in the horizontal plane; posterior to this line there is a decline, which declination is accepted also by the innominate bones; this gives the entire pelvis a shape that seems to be characteristic of the majority ot both the diurnal and nocturnal *Raptores*. The "ilio-neural" canals here present open by small apertures posteriorly, at about the point where the ilia commences to diverge, passing obliquely downwards and forwards; their anterior openings are large enough to allow a view of their internal walls. The neural spine that divides them throughout is compressed from side to side; the ilia which form their outer boundaries are convex; the neuro-spinal crest forms the roof, the basal surface being deficient, formed merely by the spine-like di- and par-apophyses of the vertebræ and the confluent neural arches. The first vertebra occupies the lowest level, the bird supposed to be standing as in Pl. I. Now, a line drawn mesial on the centra below, from the first centrum to the last, gradually rises until opposite the anterior borders of the ischiadic foramina, then curves rather abruptly downwards to its termination. The centra of the first two or three vertebræ are compressed from side to side to such an extent as to cause them to appear wedge-shaped, the common apex or edge being below; after that, however, they rapidly broaden, become compressed vertically and more cellular in structure; they are very broad from the fourth to the ninth, inclusive—then as rapidly become contracted as they approach the coccyx. Minute but numerous

pneumatic foramina are seen at or near the usual localities. The largest foramina for the exit of the roots of any pair of sacral nerves is generally in the fifth vertebra; they decrease in size as they leave them either way. In the young only the last few of these foramina are *double;* they are all double in the adult and placed one above another, a pair on the side of each centrum at their posterior borders, for the exit of the roots of the sacral nerves. The diapophyses of the anterior five sacral vertebræ are thrown out against the internal surfaces of the ilia, to which they are firmly attached, and act as braces to hold the engaged bones together. The parapophyses of the first form facets for articulation with the sacral ribs; the second and third have none; in the fourth and fifth they also act as braces in the manner above described, joining the ilia just before their divergence commences. Reliance seems to have been placed entirely in the completeness of the sacro-iliac union in the last vertebræ, for the apophysial struts terminate in that portion of the pelvic vault formed by the sacrum itself, except in the last two vertebræ, where the parapophyses abut against the iliac borders. The parapophyses of that vertebra which is opposite the acetabula are prominent, they being long and ample, reaching to the border and reënforcing that part of the pelvis that requires it the most, the vicinity of the leverage for the pelvic limbs. In other *Strigidæ* several apophyses are thrown out at this point. The posterior opening of the neural canal in the last sacral vertebra is subcircular, its diameters being about a millimetre in length. This vertebra also possesses small postzygapophyses, looking upwards and outwards for articulation with the prezygapophyses of the first coccygeal vertebra; the articulating facet of the centrum is also small, long transversely, notched in the median line, the surface on either side being convex. At every point where the sacrum meets the iliac bones union is firm and complete, though both upon the internal and external surfaces the sutural traces are permanently apparent. The anterior iliac margins, as they diverge from the sacral spine, form an acute angle, concave forwards; they have a well-marked rim or border, nearly a millimetre in width, raised above the general surface of the bone, which disappears on the outer borders as we follow them backwards. The two anterior and outer angles overhang the sacral and fifth or last dorsal pleurapophyses. From these last the marginal boundaries, which necessarily give the bones their form, are produced backwards and outwards to a point opposite the centrum of the third sacral vertebra, then backwards and inwards, forming at the above points two lateral angles. From the apices of the two lateral angles to where the borders terminate on either side in front of the acetabula with the pubic bones, the direction is such as to form a concavity on each side; the line joining the bases of these concavities, points opposite the posterior openings of the ilio-neural canals, being the narrowest part of the pelvis. The upper and at the same time the inner margins of the bones in question, from the anterior and median angle, at first approach, soon to diverge from

each other, and form the gluteal ridges and borders of those scale-like projections of the posterior portion of the ilia that overhang the acetabula. Produced now as the "gluteal ridges", they tend almost directly backwards, though very slightly inwards, to terminate in the ischial margins. The preacetabula dorsal iliac surfaces are generally concave, while the postacetabula, and at the same time that surface which occupies the higher plane, is flat, having a slope downwards and backwards, with a ventral reduplication after forming the rounded and concave posterior boundary of the pelvis. The preacetabula superficial iliac area is nearly double the extent of the postacetabula. The antitrochanterian facets that surmount the cotyloid cavities have the usual backward direction, though their surfaces look downwards, outwards, and a little forwards. The external surfaces of the *ischia* look upwards and outwards, having just the reverse direction ventrally. Posteriorly, these bones are produced beyond the ilia into finely pointed extremities, tending to approach each other. The slender pubic bones, after closing in the obdurator foramen on either side, touch and unite with the inferior borders of the *ischia* as far as the pointed ends of the latter, beyond which they are produced nearly to meet behind. The interval between the free extremities of the pubic bones in some individuals, notably "birds of the year", is very slight, less than a millimetre sometimes, approaching a closed pelvis. The circular and thoroughly perforated acetabula are formed in the usual manner by the three pelvic bones. They have a diameter of about three millimetres, and their circumferences are in the vertical plane. The ischiadic foramina are elliptical and large; they are, as usual, posterior to the acetabula and above the obdurator foramina. These last are also elliptical, and about one-third the size of the others. Should the major axes of these two ellipses be produced backwards, they would intersect and form an acute angle just within the posterior pelvic border. Viewing the pelvis ventralwise, we observe, in addition to points mentioned when speaking of the sacrum, the reduplication of the ilia, forming pockets behind and internally, that open outwards through the ischiadic foramina and inwards into the general pelvic cavity. The pelvic passage is subcircular, unclosed, with an average diameter of 1.7 centimetres vertically, and a little less transversely. The narrowest part of the pelvis measures 1.2 centimetres, the widest 2 centimetres, being taken between the iliac projections over the acetabula; the average length, including anterior neural spine, is 3 centimetres. Pneumatic foramina occur in the shallow anfractuosities, between the antitrochanters and gluteal ridges in the ilia. None of the *caudal vertebræ* are grasped by the pelvis, the posterior extremity of the sacrum always assisting to form the curve of the pelvic passage. The usual number of these vertebræ is seven, though occasionally an additional one is found, making eight in some individuals. This enumeration does not include the modified and ultimate coccygeal vertebra, the pygostyle. They are all freely movable upon one another,

and the first upon the last sacral vertebra. The articular facets upon the centra vary in shape throughout the series; that upon the first is long transversely, with a double convexity so arranged as to accommodate itself to the one on the extremity of the sacrum; they soon become uniform, to pass to the subcircular one existing between the last vertebra and the pygostyle, on which it is concave.

The pleurapophyses and parapophyses are very rudimentary or entirely suppressed. Each vertebra bears a prominent neural spine, which, from the first to the sixth, inclusive, is bifurcated; in the last two it appears as a mere primitive knobule. The transverse processes are all deflected downwards and outwards, very small in the first and still more so in the last; are largest in the fifth and sixth. Prezygapophyses are well marked; they reach forwards and articulate with the feebly developed postzygapophyses. In a few of the posterior segments there appears to be an effort on the part of the neurapophyses to overlap the vertebra next beyond them. The neural canal is pervious throughout, commencing in the first with a calibre equal to that in the end of the sacrum; it gradually diminishes, and terminates in a minute, blind, conical socket in the pygostyle. Hypapophyses are produced downwards in a few of the ultimate vertebræ. They hook forwards and articulate with the centrum of the vertebra next beyond them. Sometimes they are observed to be free, or rather resting upon a facette on the anterior margin of one centrum and extending over to the anterior margin of the centrum of the vertebra anterior to it, to meet a similar facette, as a tiny styliform process. The spinal column is completed posteriorly by the pygostyle—that ploughshare-shaped segment that articulates with the last coccygeal vertebra. Above its cup-shaped facet this bone arises as a laterally compressed plate, extending backwards and bifurcated at its extremity, as if to imitate the neural spines of the vertebræ of the series of which it is an ultimate appendage. Below the facet it projects forwards and completes the median sequence of hypapophyses of the centra, being rather larger than any of them. The posterior curve is simply inflected downwards and forwards from its apex.

The scapular arch—(See Pl. I).*—The three elements that constitute this arch are all represented and independent bones; the coracoids articulate with the sternum and scapulæ; coracoids and clavicle, connected by ligaments, lend their share to form or strengthen the shoulder-joints. The coracoid, comparatively large and strong, forms in the usual manner an arthrodial joint of restricted movement with the sternum, its lower end being in the coracoid groove on the anterior part of that bone. The inner angle of its base is about 2 millimetres from the mesial line, and 4 millimetres intervening between it and its fellow of

* It will be seen that in this figure, corresponding limbs, and other parts that are alike on either side of the body, have not been reproduced, it being thought the better way, as the bones on the side towards the observer would necessarily obscure the more remote one, complicate the figure, and show nothing additional.

the opposite side in the groove. This extremity is broad, its outer angle being beneath the third sternal rib at its point of meeting the costal border; it is compressed from before backwards. The articular facet, looking downwards, backwards, and a little inwards, is transversely concave, with a slight dividing ridge, running antero-posteriorly, converting the general concavity into two smaller ones. The coracoid when in position is produced upwards, forwards, and outwards, making, with the vertical line through its base, rather an acute angle. A limited portion of the middle third of the bone only is subelliptical on section and at all shaft-like, due to the fact that the coracoid in this bird being perhaps less than the average length as compared with the size of the bird, and, secondly, to the unusually enlarged extremities, features observable, more or less, in *Raptores* generally. The anterior groove of the upper extremity, that is arched over by the head of the clavicle above, is deep, and occupies fully the upper third of the bone. The coraco-clavicular process springs, thin and compressed, from the inner side of the shaft of the bone, at junction of upper and middle thirds, to turn upon itself, so as to be projected upwards, forwards, and a little outwards, terminating with an elliptical facet for articulation with the clavicle. The upper border of this process is concave lengthwise and articulates throughout its extent with the inferior margin of the acromial process of the scapula. The lower and thin edge of the coraco-clavicular process tends obliquely downwards, to be lost on the inner surface of the shaft of the bone near its middle. The outer wall of the anterior groove is formed by the coracoid itself, the process just described being really nothing more than a wing-like extension forming the inner boundary of the groove in this bird; it terminates above both clavicle and scapula in a rounded, tuberous head. Below this head, anteriorly and still more inwardly, the coracoid affords a vertical, elongated facet for the clavicle, while behind, looking a little outward, is the concave elliptical facet that constitutes about one-third of the glenoid cavity for the humerus, internal to which, and running first directly upwards, then making a right angle and continuing forwards, a little upwards, and outwards, the last direction being the upper margin of the coraco-clavicular process, is another facet, for the scapula. Behind and below, this bone displays one or two lines and depressions, boundaries of muscular attachments. In the middle of the anterior groove, opposite the base of the coraco-clavicular process, the shaft of the bone is perforated; this perforation is elliptical lengthwise with the shaft, and passes directly through to make its appearance on the posterior convex surface just below the scapula. This foramen transmits a branch of that cervical nerve coming from between the twelfth and thirteenth cervical vertebræ. This nerve branch, after passing through the bone, is distributed to the under surface of the pectoralis minor muscle, and its filaments ascend among its fibres. This foramen is observable also in other Owls, as *Bubo virginianus*, and in some of the diurnal *Raptores*,

as in *Accipiter cooperi;* in very many birds it is absent. The *scapula* presents little that is unusual in that bone among the class generally. It lends the additional two-thirds of articular surface to form the glenoid cavity with the coracoid; internal to this the acromion process extends forwards, touching the coracoid as described, and having a limited bearing on the clavicle. Posteriorly its blade-like length is produced, expanding, turning slightly outwards to terminate in an obliquely truncate extremity, with its point over the second dorso-pleurapophysial interspace.

What the scapula lacks in interest is amply made up by the changes observed in the last bone of the group, the clavicle. This element is broad above, much compressed from side to side throughout; it spans the anterior groove of the coracoid and touches the scapula as described above, rapidly diminishing in size as it is produced downwards and inwards by a gentle curve towards the fellow of the opposite side. The upper extremities in adult birds are separated by an average distance of 2.3 centimetres. If the sternum pointed to feebleness of flight in this little Owl, it is still further carried out by the ill-developed clavicles, which constitute that arch in birds, where they are thoroughly and firmly united below, that assists to resist the pressure of the humeri when the wings are depressed in flight, and send them back to their former position after the completion of the action. In examining again Pl. I, which represents the skeleton of an old male, we find this bone to be simply a pointed styliform process; in other individuals, and adults too, it does not even attain the length here shown; but, as if to bid defiance to all law or invariable rule governing it, we again find in very young birds cases where it becomes confluent with its fellow, forming a broad U-shaped arch, though never a very strong one. In a case of this kind the bone was finely cancellous throughout, with an extremely attenuated layer, scarcely covering it outside, of compact tissue. In Pl. I, and other individuals like it, the clavicles were pneumatic. Again, in both young and old, it may have any of its lower parts completed by cartilage, or unite with the manubrium by means of the same material; it never displays a mesial expansion of bone at the point of confluence. As already shown, the superior entrance of the anterior groove on the coracoid is a complete circuit, formed by the three bones of the group. The head of the coracoid overhangs it above; next below is the clavicle, closing it in anteriorly; lowest of all the scapula behind. A plane passed through the superior margins of this aperture would look upwards, inwards, and backwards. All the bones of the scapular arch are pneumatic, with the exception sometimes seen in the clavicle, and the foramina, to allow the air to enter their interiors, look into the enclosed groove of the coracoid just described. In the scapula the foramen is usually single and in the acromion process, single again in the clavicle; it is seen in the broadest part of the head, while in the coracoid there is generally a group of these little apertures, situated in the depression on the surface that overhangs this entrance to the coracoidal groove.

Of the upper extremity.—The upper extremity consists of ten distinct bones in the full-grown bird, omitting minute sesamoids that might exist. These are the humerus of the arm, the radius and ulna of the forearm, two free carpals, the metacarpal, and four phalanges. (See Pl. I.) The *humerus* is a long, extremely light, and smooth bone, and when viewed from above in its position of rest, with the wing closed, it reminds one of the curve in the small italic letter *f*, being concave above towards the scapula; and this bone is so twisted that this same curve is exhibited, though not quite as well marked, when viewing it laterally. The humerus is 5.5 centimetres long, subcylindrical on section at mid-shaft, at which point a minute aperture exists for the passage of the nutrient vessels that are distributed to the osseous tissue and its internal lining. This foramen enters the bone very obliquely, its external orifice being the nearest the proximate extremity. This end is well expanded and surmounted above by a strongly developed radial crest that overhangs the shaft slightly towards the palmar aspect. It occupies a line on the bone from the articular facet for the shoulder-joint to an extent shown in Pl. I. The ulnar crest, or lesser tuberosity, encloses quite an extensive fossa below, which acts also as a partial screen to the pneumatic foramina, for the humerus is highly pneumatic. They usually consist of one circular opening, surrounded by a group of many smaller ones. In young birds a very large foramen is generally present; this closes in as age advances. Between the two tuberosities is the vertical and elliptical convex facet for articulation with the glenoid cavity of the shoulder-joint, constituting the "head of the humerus". The radial crest displays palmad, a ridge for the insertion of the tendon of the pectoralis major. The distal end of the humerus is also expanded in the vertical plane and gently convex anconad, the reverse condition of the proximal extremity. It presents, for examination, the articular facets for the ginglymoid joint it forms with radius and ulna, and the superior and inferior condyles. The larger, and at the same time the superior, of these two facets is intended for the cup-shaped depression in the head of the radius, as well as a portion of the articular surface on the ulna. It is ovoid in form and placed obliquely on the bone, the inferior end of the long axis of the oval being situated the nearer the proximal extremity of the shaft. This facet is separated from the trochlea surface for the ulna by a well-marked depression; this latter is a knob-like tubercle when compared with the radial facet. The condyles and the entire articular surface are about in the same plane posteriorly; that is, neither increases the length of the bone, one more than another. Passing from the trochlea surface for the ulna towards the inner aspect of the shaft, there is to be observed a shallow depression, which corresponds to the olecranon fossa of human osteology, and in full extension of the limb allows room for that process of the ulna in this bird. The *radius* has an average length of 6.6 centimetres, and the *ulna* a corresponding length of 6.8 centimetres, so that their distal extremities, when articulated, as we ex

amine them in the closed wing, extend beyond the head of the humerus. In this position also the radius occupies a higher level than the ulna, and is the innermost bone of the two. The radius is slender, the transverse diameters of its subcylindrical shaft varying but little throughout its extent, though its extremities are expanded. From the elbow-joint, when the two bones are in position, it at first diverges from the ulna at a moderate curve, to approach that bone again to nearly absolute contact at the junction of middle and distal thirds, by a more gentle curve; from this latter point it lies parallel with the ulna to the wrist. The head of the radius is elliptical, being crowned by a depression for articulation with the oblique facet on the distal end of the humerus. Beyond, below, and to the outer aspect of this facet is another of similar form, though convex for articulation with the ulna, while still more advanced toward the distal end we find the bicipital tuberosity, and, beyond, the minute nutrient foramen; all of the bones beyond the humerus being non-pneumatic. The distal extremity of the bone in question is terminated by a little fan-like expansion that caps the ulna and articulates by its anterior convex margin with the scapho-lunar of the wrist. It is marked above by the longitudinal groove for the tendon of the extensor metacarpi radialis longus. The shaft of the ulna is nearly three times as large as that of the radius. Its outer half is straight, its inner curved towards the humerus, thereby increasing, at the proximal moiety, the interosseous space, by the assistance of the opposite curve made by the radius. The stronger end is the one involved in the formation of the elbow-joint; here is to be observed the depression for the head of the radius, or the lesser sigmoid cavity, while the articular surface beyond that occupies the entire end of the bone, directed downwards, inwards, and backwards, presents for examination the greater sigmoid cavity, the olecranon and coranoid processes, and the cavity for articulation with the oblique facet of the humerus. The greater sigmoid cavity is subcircular and of some depth; its lower and produced lip represents the coranoid process, as does its upper, better marked, and more tuberous prolongation represent the olecranon of andranatomia. Extending radiad is another concave, quadrate, articular facet for the oblique tubercle of the humerus, as the first-mentioned concavity articulates with the ulnar tubercle or trochlea. A little beyond this articular surface are various small tuberosities and depressions for the origin and insertion of muscles. Approaching the wrist, the shaft is seen to be generally smooth, and diminishes in calibre at junction of middle and proximal thirds in the nutrient foramen, while along its entire length, at certain intervals, are the slight elevations for the apices of the quills of the secondaries. The distal extremity of the ulna enters into the formation of the wrist-joint; it is not nearly as large as the proximal end. The articulating surface has a deep mesial cleft in the vertical direction, limited exterternally by an elliptical curve, internally by a double, tuberous knob for articulation with the irregularly formed cuneiform of the carpus, while

above is a roughened surface that is covered by the expanded end of the radius.

The *carpus* is composed of the *scapho-lunar*, *os magnum*, and *cuneiform*. The scapho-lunar articulates with radius, os magnum, and ulna. The radial articulation is a rather deep and elliptical concave facet, its lower border gliding over the ulna, while the distal end of the radius plays in the concavity. The opposite face of this six-sided little bone is also smooth, and is a nearly flattened surface that articulates with os magnum. The upper and lower surfaces, as well as the ends, are simply roughened and fashioned to give the proper form to that part of the joint into which it enters, and for the attachment of ligaments. *Os magnum* has become confluent with the mid-metacarpal, forming its trochlear surface for articulation with scapho-lunar, cuneiform, and ulna. The *cuneiform* is an extremely irregularly shaped bone; it appears to be rather the larger of the two free carpals, and is the lower in regard to position. It articulates with ulna and os magnum, simply. Its outer ulnar facet is elliptical and shallow, monopolizing the entire face of the bone; its inner facet is very irregular, being formed so as to accommodate itself to the ulnar tubercles, with which it articulates. Projecting towards the metacarpus, this little bone has two prongs or limbs, the inner aspect of the extremities of each possessing a subcircular facette that articulates, the outer and shorter limb with the internal trochlear margin of os magnum, on the same side; the inner and longer limb straddles the metacarpal and glides over a surface, during movements of the joint, at a point about where magnum becomess confluent with mid-metacarpal. The cuneiform has also attached to it ligaments that enclose the wrist-joint beneath—capsular ligaments of the carpus.

The *metacarpus* is formed in the usual manner, by the amalgamation of the index, medius, and annularis metacarpals, the first, second, and third, respectively. It is 3.3 centimetres long, articulating with scapho-lunar, ulna, and cuneiform at its proximal extremity by means of os magnum, that has become anchylosed with mid-metacarpal and the phalanges at its distal end. The first metacarpal is short, and fused with the second just anterior to the boundary of the trochlear surface of os magnum; it makes an angle with the shaft of the second metacarpal, its extremity being directed upwards. At its base, close to the shaft of mid-metacarpal, it bears a uniform facette for articulation with the index phalanx, a free, three-sided, pointed little bone, about 9 millimetres in length. The second metacarpal is straight; its enlarged proximal extremity is formed chiefly by the confluent os magnum; its shaft is inclined to be subtrihedral, with its broadest face looking forwards; its distal extremity is terminated by a knot-shaped enlargement, that is still further enhanced by the confluence with the third metacarpal. It bears a digit composed of two phalanges, the proximal one bearing on its posterior border, for nearly its entire length, a quadrangular expansion, that has a raised margin, leaving a single concavity radiad; a similar con-

cavity occurs on the ulnar side, but is there divided by a ridge, sloping downward into two shallow depressions. This little bone somewhat reminds one of a cleaver, with the end of its handle attached to the metacarpus. It supports at its distal extremity the second phalanx of this digit, a bone having very much the same appearance and shape as the index digit, only being longer and more pointed. The proximal ends of all the phalangeal segments are more or less expanded, in order to support the ample facets of articulation that occur among them, and the metacarpus. The third metacarpal is expanded transversely above, slender below, where it falls a little beyond the medius after its confluence with it. It also has a small, pointed phalanx, freely attached to its distal extremity, and lying in that recess formed by the shaft and posterior expansion of the first phalanx of the second digit. At a very early date, comparatively, in the life of this Owl, ossification is normally extended to many of the tendons of important muscles of the antibrachium and pinion.

Of the pelvic limb.—The lower extremity is composed of twenty distinct segments, including the patella, or just double the number found in the pectoral limb. This increase will not surprise us when we recollect the greater number of small bones devoted to the foot above those found in the hand. Its most striking feature, next to those osteological characteristics common to the family, is its extreme length, due principally to the tibia and tarso-metatarsus. All the bones of the lower limb in this species are non-pneumatic. The *femur* is comparatively of good size and strong; articulated in the usual manner, it measures 4 centimetres in length and 7 millimetres across the condyles at their widest part. At the proximal extremity, externally, above the shaft, there is a flat and roughened surface, bounded above by the curved trochanterian ridge. This surface forms the major part of the great trochanter. There is no trochanter minor present. The trochanterian ridge is the highest part of the bone, when it is held vertically; it lies in the antero-posterior plane, with the femur in its natural position, the bird standing erect; from it, sloping directly inwards and occupying the remainder of the summit between it and the head, is a smooth articular facet, broadest externally, merging into the globular head internally. With the head it constitutes the articular surface for the pelvis—it being opposed to the antitrochanterian facet of the ilium, while the caput femoris plays in the cotyloid ring. The excavation for the ligamentum teres on the latter is conical and deep, consuming a good part of the bone; it is situated on its upper and inner aspect. In looking into the relation existing among head, neck, and shaft of the femur of this bird, we must observe that if the straight line lying in the middle of the surface of the internal aspect of the shaft were produced upwards, it would pass through the centre of the facet at the summit—if anything, nearer the trochanterian ridge than it does to the head. This facet also is notably narrower just before arriving at the head than at any other point. Again, the plane passing through the external and circular bound-

ary of the head makes an angle of a good 45° with this line, so that with these facts in view we can hardly assert in the case of the species before us, as do some authors on comparative anatomy in describing this bone *in general*, that the axis of the head of the femur is either nearly at right angles with or is sessile with the shaft. It would appear, though, that it has quite as much of a neck to boast of as the anatomical neck of humerus or the neck of the scapula in works on human anatomy. The shaft throughout its length, until it begins to approach the distal condyles, where it is subcompressed and expanded antero-posteriorly, is nearly cylindrical, bent slightly backwards at its lower end, and offers for examination merely the intermuscular ridges, with the linea aspera, feebly marked, and the nutrient foramen, all of which maintain their usual positions on the bone. At the distal extremity the rotular canal, the intercondyloid notch, and the popliteal fossa are all strongly produced, giving due prominence to the condyles, internal and external, between which they form the dividing tract. The external and lower condyle is divided in two by a vertical excavation, deepest above. Of the two facets thus formed, the inner articulates with the tibia, the outer with the head of the fibula. The external surface of this condyle is flat and continuous with the shaft. The inner condyle, broad posteriorly, has a slight depression in the surface that bounds it on the tibial side, and as a rule the usual sites for ligamentous attachments about this extremity are at best but feebly represented. The *patella*, encased in the tendon of the quadriceps femoris, is situated about 3 millimetres above the rotular crest of the tibia, anteriorly, having the form of an oblate hemispheroid with its base directed upwards, the long diameter of which measures 3.5 millimetres. The *tibia* is the longest bone in this bird's skeleton, and at the same time, taking this length into consideration, the least curved or bent along the shaft; it has, however, a slight and just appreciable gradual curvature forwards that is most apparent about the junction of middle and upper thirds. Its average length, measured on the inside, is 6.7 centimetres; its extremities being expanded for articulation, above with the femur, below with the tarso-metatarsus. These expansions are of about equal dimensions, though differing vastly in form, in this respect being unlike some of the diurnal *Raptores*, in which the distal condyles constitute the smaller end of the bone.

Among the most important points presented for examination about the head is the articular surface that crowns it above for the condyles of the femur. This is subquadrate in form, uneven, highest at the inner and anterior angle, sloping gradually to the opposite one, bounded almost entirely around by a raised margin, that is most feebly developed posteriorly, and at a point anterior to the head of the fibula, where it is absent. In front this border may be nominated the rotular or epicnemial ridge, though it is no more prominent there than at any other point, but in many birds it is so produced as to produce a process of

some size, to which these terms are applied. Externally and posteriorly the margin is roughened for the attachment of ligaments that bind the head of the diminutive fibula to this bone. In the middle of this articular surface is to be seen a tuberosity, on either side of which are the depressions for the femoral condyles. Produced downwards, anteriorly from the rotular ridge are the cnemial ridges; these have their crests bent slightly outwards, and they merge into the shaft below, abreast the superior point of the fibular ridge. Of the two, the outer or ecto-cnemial is the shorter; that is, it does not extend so far down the shaft as the inner or pro-cnemial. They have between them an ovate concavity, with the larger end above, the lower end subsiding upon the shaft with the ridges themselves. The vertical elevation on the external aspect of the shaft for articulation with the fibula runs down the side but a short distance; a little below its abrupt termination may be observed, in a line with it, the nutrient foramen, entering very obliquely from above downwards. After leaving the fibular ridge as far as the point where the bone begins to expand transversely at the distal extremity, the shaft is remarkably smooth and nearly cylindrical. This transverse and distal expansion is checked, both anteriorly and posteriorly, by abruptly meeting the distal condyles, the point of meeting perhaps being rather the higher behind. The condyles, differing but little in size, are singularly uniform as to shape, with their curved surfaces downwards, being flat on their outer aspects, with a raised rim bounding them in each case. They stand out prominent and apart. Anteriorly their convex surfaces are the widest, behind they slightly approach each other, and the articular convex surface is narrowest on the outer condyle. The intercondyloid notch is deep, and appears equally well marked throughout its extent. Immediately above it, anteriorly, there is a deep triangular depression; another, and more shallow one, is found behind in the corresponding locality. Up the shaft a short distance on the inner side, anteriorly, is a little tubercle, to which is attached the ligament that binds down some of the strong tendons of the extensors. This ligament crosses the anterior triangular depression mentioned above, obliquely, to be inserted near the external condyle superiorly. This is the arrangement also in *Bubo virginianus*, but in some of the Hawks this ligamentous bridge has become thoroughly ossified, forming a strong bony band across the concavity in question. It is interesting to remark here, however general the rule may be as applying to the diurnal and nocturnal *Raptores*, that whereas this band is ligamentous in the tibia in some of the Owls, a bony one fulfilling the same function is found in them just below the head of the tarso-metatarsus; these conditions are just reversed among some of the Hawks. Usually, in old birds of this species, the *fibula* is firmly anchylosed to the entire length of the fibular ridge of the tibia; arching outwards, its head, surmounted by an antero-posteriorly elongated facet, rises a little above that bone at the point where it is attached to it by ligament. This is

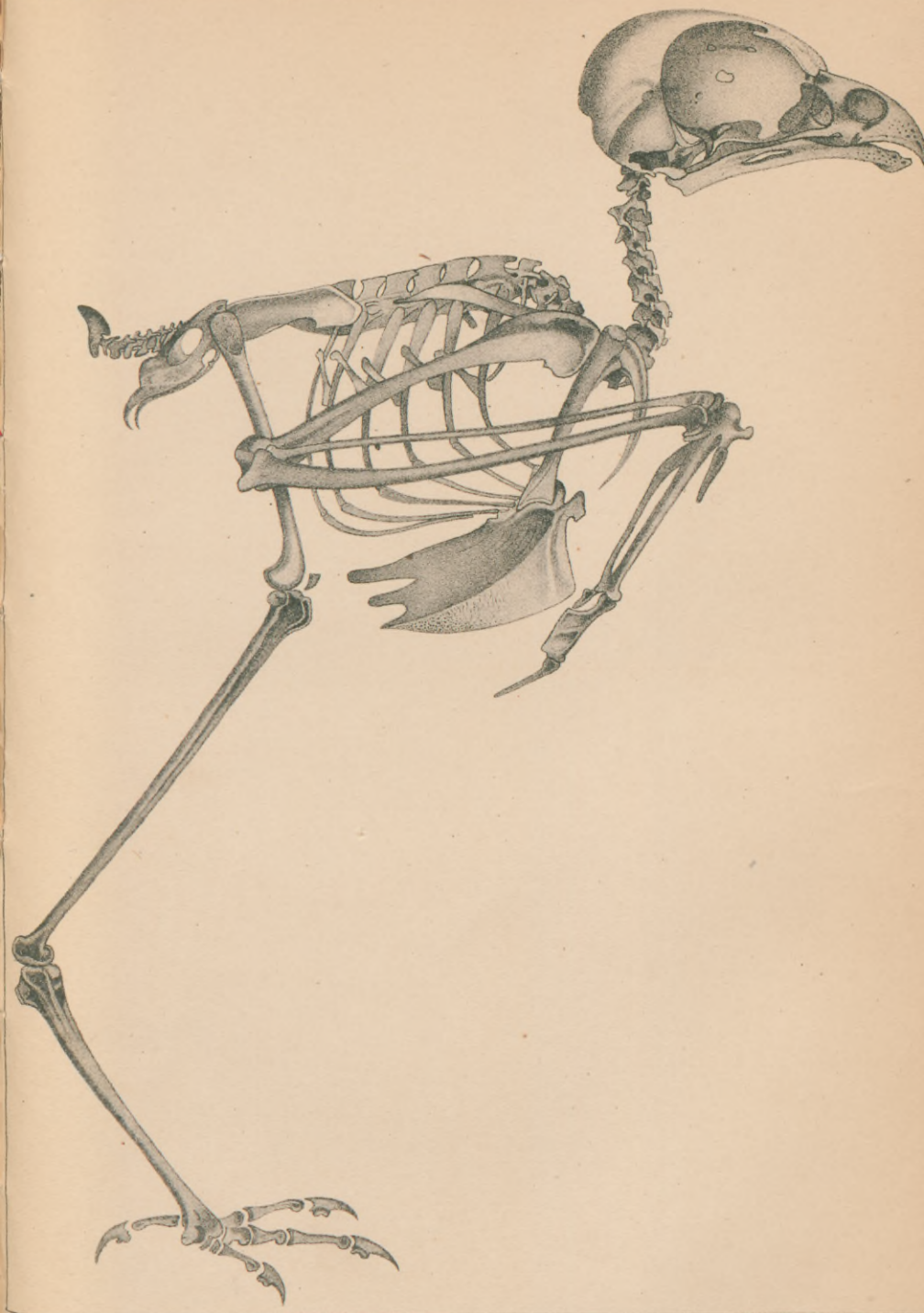
the larger part of the shaft in regard to size. Below the ridge this bone becomes simply a delicate little spine, that merges into the shaft of the tibia at about the junction of middle and distal thirds, though it may be traced after this as far as the middle of the outer condyle, where it terminates by a minute tubercle. The head is notched externally, near the centre, and has lodged at that point a small sesamoid that is in the lateral ligament of the knee-joint. Posteriorly on the shaft, about midway down the superior tibio-fibular anchylosis, we observe a small tubercle for the insertion of the tendon of the biceps. The long segment that exists between the tibia and the phalanges of the pelvic limb is the bone *tarso-metatarsus*, or the confluent metatarsals of the second, third, and fourth toes with certain tarsal bones at its proximal extremity. It measures down the anterior aspect, mesially, 4.6 centimetres, and has its extremities enlarged for articular purposes, in common with other long bones of the skeleton. At its proximal end the bone presents superiorly two concave articular surfaces for the condyles of the tibia. They appear nearly on a level with each other, the bone being held vertically. The inner and larger of the two is elliptical in outline, antero-posteriorly; the outer and smaller is fashioned off behind by a tuberous process, directed upwards and outwards. Between these two surfaces arises a prominent tuberosity, that in the articulated limb enters the intercondyloid notch of the tibia quite accurately, and is intended for ligamentous attachment. Anteriorly and internally a groove exists that runs down the shaft, to disappear a little above its middle. This canal is deepest immediately below the articular expansion, and is here bridged over by a little arch of bone, a millimetre in width, that serves to bind down and hold in its proper place the tendon of the long extensor of the toes. Posteriorly there is a much deeper and longer tendinal canal, that extends the entire length of the shaft, being shallowest at the middle and most capacious at the proximal extremity; this is bounded over and internally for a short distance below the head of the bone by the calcaneal process, a thin lamina of bone that has a foramen near its base; this process is surmounted by an elliptical and compressed tuberosity, placed vertically. The opposite wall, above, of this groove is also thin, and extends, in common with the calcaneal process, directly backwards. There are two other foramina seen at this end of the tarso-metatarsus; one just at the external termination of the bony bridge mentioned above, and the other outside and a little above it. Their posterior openings are immediately behind the anterior ones, or, in other words, they do not pierce the shaft in any way obliquely. The shaft of this bone is notably square on section for the major part of its extent, being encroached upon, however, both before and behind, by the aforesaid tendinal grooves. The tendons, especially those that occupy the posterior canal, are very prone to ossification, forming quite sizable bones in the adult, the largest of these being equal to the fibula in bulk, exclusive of course of the head of that bone, and not being as long. Returning to the tarso-metatarsus, we find

at its distal extremity, for examination, the trochleæ that articulate with the rear segment of all the toes except hallux. Viewing this end with the bases of these trochleæ towards one, we find the general outline made by them to be truly crescentic, with the horns having a tendency to approach each other behind. The outer trochlea is the highest and longest from before backwards; the other two are about on the same level, the inner one having a posterior and internal process, while the middle one is possessed of a median cleft traversing its face antero-posteriorly. They are sharply divided from each other by narrow slits, that extend up as far as the articulating part, and are continued on the anterior aspect of the shaft for a short way as delicate groovelets. A foramen is situated in the outer of these, that gives passage to the anterior tibial artery, and is comparatively larger than usually seen in the Owls. Behind, the tendinal groove expands, and is bounded distally by the concave border formed by the trochleæ. Upon its internal margin, just above the extremity of the bone, it shows an elongated but feebly marked depression of about 3 millimetres in length. This facet articulates with the os metatarsale accessorium, which is joined to the bone by ligament. This little bone in this bird has an average length of 4 millimetres. It is twisted upon itself, and bears upon one border a convex, smooth surface for the tarso-metatarsus, while distally it has an articulating surface, resembling more the mid-trochlea than any other, for the proximal segment of the hallux. Above it is sharply grooved for the tendon that goes to that toe. The *toes* are four in number, and their bony segments follow the rule that governs the greater part of the class *Aves*; that is, first, second, third, and fourth toes have 2, 3, 4, and 5 phalanges allotted to them, respectively. The first phalanx of the hind toe is more compressed from side to side than in the other toes, possessing more of the characteristics of the second joints. Its posterior facet, that articulates with the accessory metatarsal, fits accurately into the cleft surface seen on that little bone. Anteriorly the facet has a median groove, forming two vertical convexities for the double concave facet on the claw, with its dividing ridge. The claws are all a good deal alike, varying in size, the rear one being the most compressed laterally. They are pointed, arched, and nearly conical, the horny thecæ that cover them during life only being grooved on the under side. Their proximal ends have an articulating facet for the next phalanx behind them; this is so arranged that they can be more smartly flexed than any of the other joints of the foot, due to the convex articulating surface extending well beneath on the phalanx they meet. On the under sides of their proximal extremities is a tuberosity for the attachment of the flexor tendons; it has on either side, below, an oval foramen to allow vessels and a nervelet to pass to the extremities of these ungual phalanges. The first joint of the second toe, and the first and second of the third, are thickset and short, articulating internally with the tarso-metatarsus, and having their facets so arranged as to allow of motion only in the one

plane. These bones may almost be said to interlock with each other, with their superior projecting processes behind fitting closely into the deep groove intended to receive them on the anterior faces of the joints to their immediate rear. The other undescribed phalanges of these two toes resemble the proximal segment of hallux. The fourth or outside toe possesses five phalanges, but the three innermost segments are very short, and are really nothing more than one of the middle type of phalangeal bones, such as the third on the mid-toe, divided into three nearly equal parts, the proximal and distal pieces retaining all the characteristics of that bone, while the middle segment is simply a mid-section of the shaft. This arrangement, however, together with the manner in which the proximal phalanx, if it may be termed so in this bird, articulates with the long and elevated trochlea on the tarso-metatarsus, gives this toe a versatility and a power to be thrown outward and, to a limited extent, to the rear, not enjoyed by any of the other toes, constituting one of the most interesting anatomical features that we find in the family *Strigidæ*.

PLATE I.

The skeleton of *Speotyto cunicularia hypogæa.*



Thos. Sinclair & Son, Lith.

SKELETON OF SPEOTYTO CUNICULARIA VAR. HYPOGÆA.

PLATE II.

The skull, sternum, pelvis, etc., natural size.

Fig. 1. The skull from above.

Fig. 2. The skull from below.

Fig. 3. The mandible from above.

Fig. 4. The pelvis from below.

Fig. 5. Transverse section of thorax, showing a dorsal vertebra, with the corresponding pair of ribs and corresponding section of the sternum.

Fig. 6. The sternum from below.

Fig. 1.

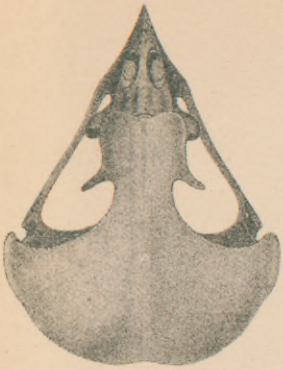


Fig. 2.

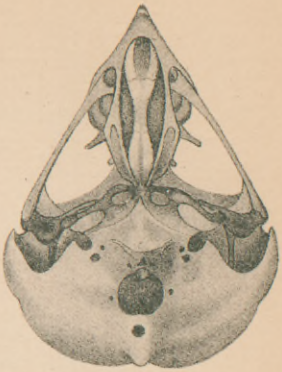


Fig. 3.

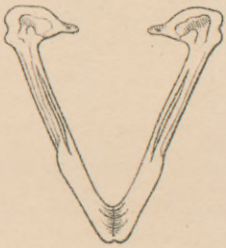


Fig. 4.

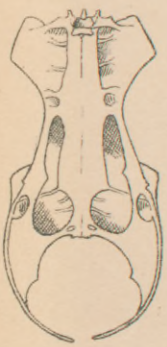


Fig. 5.

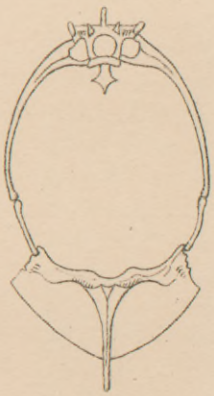
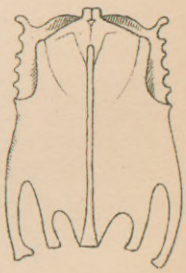


Fig. 6.



Thos. Sinclair & Son, Lith.

OSTEOLOGY OF SPEOTYTO CUNICULARIA VAR. HYPOGÆA.