NOTES ON THE ANATOMY OF *SPEOTYTO* *CUNICULARIA HYPOGÆA*.

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AMONG my alcoholic birds that I collected in Arizona and New Mexico, during the years of 1884 to 1888 inclusive, I find two very fine specimens of the Burrowing or Prairie Owl (*Speotyto*), and, as there are certain parts of the anatomy of this remarkable species, so far as the writer is aware, which have not as yet received the attention of the ornithotomist, it will be my aim in the present contribution to offer a few remarks upon the subject. Naturalists are quite familiar with the two species of this owl and their geographical ranges; their habits and nidification; and something of their external or topographical anatomy; so these chapters in their life-history need nothing from me here.

THE PTERYLOGRAPHY.

Upon plucking a specimen of *speotyto*, we find that it possesses *twenty-five* remiges, and *twelve* rectrices. These numbers, it would seem, agree with the majority of the *Striges*; but in the remainder of its pterylography, *Speotyto* exhibits some marked departures from the patterns laid down for this order by so eminent an authority in such matters as Nitzsch.¹ The Burrowing Owl, however, agrees in possessing *feathers without an aftershaft, and a tuftless oil-gland*, points which essentially distinguish this group pterylographically. Differing from both *Strix bubo* and *Hybris flamca*, as drawn by Nitzsch, *Speotyto* has its head completely feathered, crown, occiput, sides and throat; and, furthermore, the anterior and posterior cervical tracts are notably broad, which is contrary to the rule in these nocturnal rapacious birds, according to the writer just quoted (see Figs. 1 and 2 of the Plate). About the middle of the neck, the anterior cervical tract bifurcates, each bifurcation passing down to

¹ *Pterylography*, Nitzsch, C. L. (Dr. Sclater's translation; Ray Society edition, Lond. 1867). pp. 67-71, *Taf.* II., Figs. 8-11.

merge with the anterior parts of the continuous humeral and ventral tracts at the shoulder. A few feathers are also found at the hinder part of the fossa between the limbs of the *os furcula*. The *ventral tract* is divided; the inner branch being long and narrow, composed, as it is, of only two rows of contour feathers. Either row passes almost in a direct line to the outer margin of the vent on the same side, being strictly defined for the lower moiety of its course; more diffuse above. On the other hand, the external branch is very broad, and strongly marked, as shown in Fig. 2, — its postero-external angle throwing upwards towards the shoulder “a hook” of large contour feathers; the area at the outer aspect of the breast between this latter line and the external branch of the ventral tract is diffusely feathered with a number of large feathers.

Nitzsch evidently had a specimen of the present species (*op. cit.* p. 70), but I am very much inclined to believe that it was in poor condition, from what he says about it, and the next form he describes (*Strix pygmæa*); probably in moult, and kept too long besides. In any event he failed to note the characters I have just given for the pteryłæ of the ventral aspect of this owl's body. Anteriorly the legs are pretty well feathered, and sparsely distributed down-like feathers of no great size cover the tarsi in front, and become exceeding small as they pass to the toes on their upper surfaces. It is said that the shanks are more extensively denuded in the Floridan form of the Burrowing Owl.¹

Our subject has its “alar tracts” strongly marked, the feathers being regularly disposed on their dorsal aspects, consisting of a row of four or five feathers running from each quill in the direction of the patagium.

Dorsally, the spinal tract shows a conspicuous fork at a point between the shoulders, as shown in Figure 1 of the Plate, and a single and more feeble row of feathers connect the apex of either limb of this bifurcation, with the hinder part of the spinal tract where it begins again, in the middle line. From this latter point, it grows stronger and broader once more, and upon approaching the large papilla of the uropygeal gland, it surrounds that structure; the caudal region between it and the rectrices being well feathered.

¹ COUES, E., *Key to North American Birds*, 2d ed., p. 517. (*S. c. floridana*.)

Strong "crural" and "humeral" tracts characterize the pterylography of *Speotyto*, the feathers of the latter being very long and large. The femoral pterylæ are fairly well pronounced in this owl, and a few scattered feathers may occur beyond it, as do a few between the limbs of the bifurcation of the spinal tract, though these latter are inclined to be of the downy variety.

This description goes to show, then, that *Speotyto* has a pterylography, in some particulars, quite its own, though it is possible that it may largely agree with such genera in this respect, as *Glaucidium* and *Micrathene*, but I have not specimens of these at my hand at present, wherewith to compare it. *Speotyto* has no ear-valve, and a few delicate feathers are distributed over the eyelids. As compared with the species of owls described by Nitzsch, its pterylography is peculiar in the marked and unusual breadth of the tracts, and in that the head is completely covered with feathers upon all its aspects.

ON CERTAIN STRUCTURES OF THE HEAD.

Seven or eight years ago the writer published a detailed account of the skeleton of the Owl we now have under consideration, so that we will not be required to touch upon that part of its anatomy here, or only in so far as some special point seems to demand it (*U. S. Geol. and Geogr. Survey of the Terr. Dep't of the Interior*. Hayden's 12th Ann., pp. 593-626, 3 pls.). Upon removing the teguments of the head, we are to note that the moderately large eyes of *Speotyto* look forwards and outwards, but do not project as prominently as we find them sometimes in other *Strigidae*. The nictating membrane is attached in the usual manner to the antero-superior part of the eyeball, which latter possesses a deep encasement of sclerotal plates. As in most Owls, the frontal region of the cranium is narrow, and the *supraorbital processes* are spiculiform, projecting backwards and a little outwards; to the inner side and apex of either of these, and to the entire posterior orbital margin, is attached a dense, fibrous membrane, which covers the globe of the eye posteriorly, being inserted finally to the cranium in front of the ear, to the zygoma slightly, and to the under side of the eyeball, upon which, throughout its extent, it is drawn tightly down.

In front of the orbital cavity is a spongy bone of some size, which I described in my memoir upon the osteology of *Speotyto* as the *lacrymal*, and I still take it to be such, and believe the processes above referred to as the supraorbital processes, to be developments on the part of the frontal bones. Two skeletons of nestlings of *Bubo virginianus* seem to indicate this: specimens kindly collected for me by Dr. W. S. Strode of Bernadotte, Ill.; though in these, these processes are exceedingly small. Among certain Hawks and Falcons the arrangement is very different; for in such a species as *Falco sparverius*, for example, these processes are very long and conspicuous; but they are here the true lacrymals, and send down a descending process, which, in either one, reaches to the maxillary, and articulates with the entire outer margin of the *pars plana*. In this little Falcon no such bone exists as the lacrymal which I have described for *Speotyto*, its place being monopolized by this descending limb of the very differently constructed lacrymal in it, and to which I have just alluded. In such characters as these, then, we find truly a great difference between such species as our Burrowing Owl and the Sparrow Hawk.

Removing the vault of the cranium, and breaking down the walls of the brain-case, here composed of very delicate tables and abundant open diplotic tissue, we find the brain of a form common to many *Strigidae*,—the cerebral hemispheres large, smooth, and somewhat pear-shaped, mounting as they do considerably above the rather small cerebellum. The pineal body is of no great size, while the optic lobes, as well as the optic tracts, are situated in the deep excavation formed at the bottom of the cranial casket. All the cerebral nerves, including the first pair, are of mere thread-like proportions, as soon as they are given off from the brain mass; and, indeed, the medulla oblongata is of small calibre compared with the size of the bird.

An interesting feature is seen at the side of the skull in *Speotyto*, where the tendon of the temporal muscle passes through a foramen, above the squamosal, on the way to its insertion upon the mandible. This arrangement does not exist in such species as *Asio wilsonianus* nor *Syrnium nebulosum*; the former of these, with a very different skull from the Burrowing Owl, has simply a minute notch devoted to the same purpose;

while in *Syrnium*, with another very dissimilar pattern of skull, this is shown in a deep groove.

The eyes of *Speotyto* present nothing worthy of special note, beyond what we know of these organs among the Owls generally. We observe, that the optic nerve is of rather small calibre, for a strigidine bird, while this species affords an excellent type upon which to study the special musculature of the eye, and the ever interesting arrangement of the pyramidalis and its tendon.

This specimen has no *vomer*, its place being superseded by a median sheet of dense fibrous membrane; and I am strongly inclined to believe that this bone never ossifies in *Speotyto*. A skull of *Syrnium* at my hand also lacks this element, while in *Asio wilsonianus* it is very small, and of peculiar construction, being sharply pointed in front, hollow, and light, and delicate throughout. *Falconidæ* usually always have a good-sized vomer, but from what has just been said, we must believe that this is the exception in the Owls.

Nothing peculiar seems to characterize the internal ear, which I carefully examined; nor the tongue, nor the upper larynx.

THE PECTORAL MUSCLES.

For a bird that so seldom seems to resort to flight of any great extent, *Speotyto* has its pectoral system of muscles very well developed.

The *pectoralis major*, although not very thick, as the sternal keel is inclined to be shallow, makes up in width, and on the whole would be considered rather a powerful muscle. It exhibits the usual origin and insertion, completely covering the next two to be noticed.

Of these the *pectoralis secundus* is also of quite a considerable bulk, arising from its most usual site on the anterior aspect of the sternal body, and carina, it shows the bipenniform structure for which it is notorious, and its tendon passes up through the tendinal canal, formed by the bones of the shoulder girdle, to be inserted into the humerus after the common fashion as seen among birds generally.

A *pectoralis tertius* of no mean dimensions, but presenting nothing peculiar, is also found in this Owl, and it completely covers, in my specimen, the row of sternal articulations of the hæmapophyses of either side.

CERTAIN MUSCLES OF THE FOREARM AND THIGH.

Professor Garrod has already pointed out that the *expansor secundariorum* muscle is absent in the *Strigidae* (*Coll. Sci. Mem.*, p. 329), and I find *Speotyto* to be no exception to the rule. On the other hand, the patagial muscles of this family are not alluded to by him, and here offer several points of interest; for although the origin and insertion of the *tensor patagii longus* are as we find them in nearly all ordinary birds, the same cannot be said of the *tensor patagii brevis*. This latter has its carneous portion at the shoulder much as we always find it, while its slender tendon in descending for insertion upon the *extensor metacarpi radialis longus* of the antibrachium, bifurcates at about the middle of its course,—the inner or proximal slip attaching itself as usual to the tendon of the aforesaid extensor of the forearm, and from the point of its insertion a tendon passes by a gentle curve over the outer aspect of the muscles of the antibrachium, towards the wrist, and gradually approaches the ends of the quills of the secondary feathers, into which it finally becomes inserted at a point about opposite the site of the middle and distal thirds of the ulna. To return to the remaining slip, the anterior one, of the bifurcated tendon of the *tensor patagii brevis*, it too becomes inserted into the tendon of the *extensor metacarpi radialis longus* at a point situated about half a centimetre beyond the insertion of the proximal slip, and in the same line. It will be interesting to compare this arrangement of the short tensor of the patagium in other *Strigidae*, as well as in Raptorial birds generally. Before writing out this account of it I very carefully examined the muscles in question in both limbs, and found them to agree exactly.

Speotyto lacks the *biceps slip to the patagium*, as seems to be the case in all Owls.

Passing to the muscles of the thigh, we find the femoro-caudal present, and for a representative of this family, rather large; the ambiens, the tensor fasciæ, the semitendinosus and its accessory slip, and the accessory femoro-caudal are all absent. This arrangement agrees with the several species of Owls examined by Garrod, though that distinguished ornithotomist did not apparently examine the present bird, while he did investigate this point in at least three forms of *Athene*.

Incidentally, I may remark here, that in *Speotyto* the main nerve of the leg is the sciatic; the main artery, the sciatic artery; and the main vein, the femoral.

Nowhere in Garrod's work do I find a place where he paid any especial attention to the arrangement of the plantar tendons in the Owls, and he seems to have let this matter rest with his investigation of four or five species of diurnal Raptores; and of these he says that "the *flexor longus hallucis* divides into two moieties opposite the lower end of the tarso-metatarsus, one of which runs to the hallux. The other part is the representative of the vinculum of the above-mentioned birds; it is peculiar, however, in that, instead of joining the tendon of the *flexor perforans digitorum*, before it is distributed to the anterior toes, it mostly runs down to blend with the slip which is associated with the inner of these (digit 2) only [figures it for *Tinnunculus alaudarius*]."

"In *Geranoætus aguiæ* and in *Polyborus*, besides the special tendon from the hallux-muscle to the second digit, there is a broad, thin vinculum present, as in *Gallus*. In the Accipitres Diurnæ, the arrangement of the tendons, therefore, differs in different groups—in *Baza* their distribution being quite normal, that is, as in the first described; in *Polyborus*, *Haliaætus*, *Tinnunculus*, and *Geranoætus*, this condition is combined with a special tendon to the second digit, which greatly increases its power of flexion." (*Coll. Sci. Mem.*, pp. 293, 294.)

Now of the *Cathartidæ*, he further adds, in the same place, that, "the two deep flexors descend beyond the ankle-joint independently, as usual; after passing which, generally about one-third down the tarso-metatarsus, they blend completely, *before* any slip has been given off. From the conjoined tendon thus formed the tendons of distribution spring, four in number, one to the hallux, and others to each of the three anteriorly directed toes [he here directs attention to his figure of *Buceros rhinoceros* to show it], that to the former being generally separated off before any of the others." (*op. cit.* p. 294.)

Upon carefully examining these parts in my specimen of *Speotyto*, I find the arrangement a little different even from any of these; in the leg we find both the flexor muscles distinct, and their tendons remain distinct to a point about four or five millimetres *below* the hypotarsus, where they not only completely

blend, but coössify, forming by their union a strong, straight, bony rod, which is harbored in a very considerable groove down the back of the tarso-metatarsus, its distal end even extending a little beyond the free accessory metatarsal of the hallux. Here it splits up into four nonossified tendinous slips, which are distributed to the four digits in the usual manner.

The foregoing facts not only prove that the arrangement of the plantar tendons differs among the diurnal Raptores, but a still different arrangement is to be found in the American *Cathartidæ*, birds in no way especially related to the former; while *Speotyto* goes to show that at least one other peculiar arrangement of these tendons is to be met with among the *Strigidæ*. This Burrowing Owl has the power of reversing the hallux, but it is not the normal position of that toe. It may be as well to add here that in this specimen the tendon of the superficial flexor at the back of the tarso-metatarsus is also completely ossified.

THE VISCERA AND CERTAIN OTHER STRUCTURES.

An examination of the heart and great vessels reveals the fact that the first-mentioned organ is comparatively large for the size of the bird, and elongated rather than of an ovoid shape. Both carotids are present, and ascend the neck to the head through the usual canal intended for them on the anterior aspect of the cervical vertebræ.

Turning to the *trachea* and *syrinx*, we find the former for its lower half, somewhat compressed from side to side, the reverse of the case in the upper part of this tube. Its rings are ossified; not so, however, the ring of the bronchi. Two of the semi-rings and the *pessulus* are ossified, and the former open wide apart posteriorly. But two pairs of muscles appear to be present, the "sterno-tracheales," and the "tracheo-laterales."

The *liver* is divided into *two* very nearly equal-sized lobes, joined with each other by a very slender band; and I fail to discover the presence of any *gall-bladder*.

Of considerable calibre, the *œsophagus*, including the *proventriculus*, has a total length of 9.5 centimetres, the latter organ merging gradually into the ovoid and somewhat muscular gizzard. This is lined with a firm corneous coat, and the pouch when opened contained a few large black beetles, being in a

partly digested condition. The thickest part of the wall of the gizzard is about 4 millimetres; this is at its posterior aspect, and quite near the proventriculus. Coues has stated (*Key*, 2d ed., p. 498) that the Owls have "short and wide intestines," but not so, judging from the specimen before me, the Burrowing Owl, *Speotyto*, as in it the intestine is of unusually small calibre, and *very long*, measuring from stomach to anus no less than 39 centimetres. Each cœca has a large bulbous extremity though its pedicle is very slender; it measures 3.4 centimetres, and it springs from the intestinal tube (at the same point with its fellow), 4.6 centimetres above the anal opening.¹

Other organs and parts presented in the economy of this Owl were examined quite in detail by the writer, but nothing of very great import was discovered, beyond what is common to the morphology of the group as a whole. The specimen chiefly used by me in these dissections was extraordinarily fat, especially at the root of the neck, and overlying the flanks, and lower part of the dorsum and abdomen.

This Owl, in common with some other *Striges*, has an antero-posterior foraminal perforation through either coracoid, a fact which I pointed out in my memoir in the Osteology of the bird, and I further said there, that "this foramen transmits a branch of that cervical nerve coming from between the twelfth and thirteenth cervical vertebræ."² More strictly speaking, I find upon reëxamination, that although I have given the nerve's exit correctly, in reality it is the anterior branch of the brachial plexus, and after passing through the aforesaid foramen in the shaft of the corresponding coracoid, from behind, forwards, it is distributed to the *pectoralis secundus* muscle, following its tendon on the aspect next the body of the sternum, while the minute nerve-fibres branch up among the fibres of the muscle. This same interesting condition obtains in *Bubo virginianus*, and some Hawks of the genus *Buteo*.

¹ Both the intestine and mesentery in this specimen of *Speotyto* had sparsely sprinkled over them, sometimes in groups of four or five, and sometimes singly, little ovoid bodies about the size of No. 10 shot, pure white in color, and having all the appearances of lime-like deposits in the tissues where found.

² SHUFELDT, R. W., *Contributions to the Anatomy of Birds*, p. 612.

CONCLUDING REMARKS.

The notes offered in the present paper may fitly be considered as supplementary to my more extended memoir upon the *Osteology of Speotyto*, already alluded to above. I look forward with pleasure to some day devoting considerable attention to the American Raptorial Birds as a group, and from what I have thus far seen of them I have every reason to believe that they will afford characters of more than usual interest; the Owls, in particular, are, in many instances, very dissimilar in their skeletons and probably so in other systems of their economy. Anatomically, too, the Hawks, Falcons, and Eagles offer much that requires thorough investigation, and for this work, the writer is continually employed in bringing together his material.

My researches upon the anatomy of *Speotyto*, as here set forth, most conclusively go to show that our American species of Owls — and there are a number of them — require far more extended investigations of their pterylography than they have received up to the present time. *Speotyto* offers, as I have shown, peculiarities in this regard, not observed by that great investigator of this subject, Nitzsch, and what I have here described, surely needs comparison with a number of our *Strigæ*, and I dare say with forms from the avifaunæ of other countries where Owls occur.

Another matter which needs attention, is to ascertain which of our Owls possess a *vomer*, and which do not; it would seem that this bone of the cranium never ossifies in this Prairie Owl; another interesting fact.

Further comparison is needed of the patagial group of muscles in these birds; indeed, it would repay the labor to make quite an exhaustive study of this for the diurnal and nocturnal Raptorial birds, to include the *Cathartidæ*. *Speotyto*, as I have shown, has peculiarities in this direction also.

Again, the arrangement of the *plantar tendons* sadly needs looking into, and thorough comparisons made in the groups to which I have just referred. What has been brought out in the present paper, goes to prove that our subject here also affords structures at variance with the known arrangement of the same parts in certain diurnal birds of prey.

And so on through the remainder of the economy of *Speotyto*,

much of which affords, here and there, other suggestive characters. Nevertheless it is very plain to be seen, from all this, that at the present writing it cannot be predicted with safety what are the nearest affines of this Owl as indicated by a complete knowledge of strigidine morphology ; but the writer feels that he has the right to hope that the present outline, with the salient features in the anatomy of this unique owl, presented as they here are, may assist to some extent the solving such problems.