OBSERVATIONS

ON

THE ANATOMY OF THE TOUCAN.

THE organs of digestion in the Toucan present a general simplicity of structure, which accords with its geographical position and power of assimilating both animal and vegetable food, so abundantly provided by Nature in a tropical climate. The amplitude of the œsophagus and general width of the intestinal canal correspond to the magnitude of the beak. There is no lateral dilatation or crop, nor is the gizzard so encroached upon by its muscular parietes as to render such a reservoir for the alimentary substances necessary. The intestinal canal is equally devoid of lateral pouches, or *cæca*: the gastric glands are of a simple form, and are disposed, for the extent of an inch, around the termination of the œsophagus. The communication of the gizzard with the *proventriculus* is free, and readily permits regurgitation to take place. This act has been observed in two living species of Toucan (*Ramphastos Erythrorhynchus* and *Ramph. Ariel*, Vigors); and as the substances so regurgitated were, after undergoing a second mastication, again swallowed, it may be compared to the rumination of herbivorous quadrupeds.

The intestinal canal does not exceed the length of the body, including the bill. The general structure of the digestive apparatus of the Hornbill agrees with that of the Toucan.

The liver of the Toucan is composed of two lobes, of unequal size, joined by a small band, the margins of the lobes being more rounded than usual. There is no gall-bladder, and in this deficiency the Toucan manifests an affinity to the *Picidæ* and *Psittacidæ*, among the *Scansores*; while the Hornbill, on the contrary, resembles the *Corvidæ* in the large development of its biliary receptacle. A small hepatic duct enters the duodenum near its commencement; and a second duct, about two lines in diameter, passes to a more distant part of the intestine, where it terminates close to the insertion of the two pancreatic ducts.

The kidneys are composed of three lobes, of which the middle one is the smallest; their length is $1\frac{1}{2}$ inch; their surface is convoluted, though in a less marked degree than in reptiles. Between the anterior extremities of these glands, in a female specimen of *Ramphastos Ariel*, was situated the ovary, of a triangular shape, and apparently healthy in structure. The *ova* were like minute granules, and disposed in a convoluted manner. The supra-renal glands were imbedded in the posterior part of the ovary. The oviduct was as large as a crow-quill; it commenced by the usual fimbriated and wide aperture, was slightly tortuous at the commencement, and then continued straight to the *cloaca*.

Among the varied forms of tongue which birds present, that of the Toucan is one of the most remarkable. Its length from the aperture of the *glottis*, in a full-grown *Ramphastos Toco*, was six inches. The posterior ridge, or backward-projecting process, was broad and finely notched; it was situated about 4 lines from the *glottis*. Anterior to this process the tongue is soft and minutely papillose for the extent of 4 lines, and here, most probably, the sense of taste resides: the rest of the organ consists of a transparent horny *lamina*,

flattened horizontally and supported by the anterior process of the *os hyoides*, which forms a ridge along the middle of its inferior surface. At about four inches from the extremity of the horny *lamina* the margins become obliquely notched, and these notches, becoming deeper and closer together towards the extremity, occasion the bristled appearance on each side of the tongue. These bristles, Mr. Vigors observes, were generally applied to the morsels of food whilst held between the mandibles previously to being swallowed.

The *cornua* of the *os hyoides* are $1\frac{1}{2}$ inch in length. The *trachea* is narrow, and simple in its structure, the rings somewhat flattened and decreasing in diameter towards the inferior extremity, from which a single pair of muscles pass off to the *sternum*. The length of the lower fourth of the tube, and the state of tension in the *bronchia*, are regulated by a pair of small muscles, which, arising from the sides of the tracheal cartilages, are inserted into the bone of divarication at the extremity of the *trachea*: and that this part of the tube is subjected to variations in length is indicated by the tortuous character of the recurrent nerves attached to the sides of the *trachea* at this part. The lungs are small in proportion to the size of the bird, but of the usual form and structure. The abdominal air-cells are of small size. The heart is of a more oblong form than in general; its *apex*, as it were, truncate; its length 1 inch.

The pectoral muscles, as in the *Psittacidae*, are but feebly developed, and the keel of the *sternum* is of moderate size, not projecting more than half an inch from the plane of the bone. The *sternum* has four notches at its posterior margin. The clavicles, or lateral halves of the *furcula*, are here, as in the *Psittacidae* and *Struthionidae*, separate; they are 1 inch in length, slender, pointed at their lower ends, and joined to each other and to the *sternum* by ligament only.

The peculiar motions of the tail called for a particular examination of that part. It is difficult to state the precise number of the caudal *vertebræ* in consequence of the terminal ones being ankylosed, requiring for this purpose the examination of a young specimen at a period before the *anchylosis* takes place. In the skeleton of a Black-billed Toucan which I have examined, it would appear that three *vertebræ* are thus ankylosed, making the entire number of coccygeal *vertebræ* nine. The Woodpecker has also nine caudal *vertebræ*, and this seems to be the greatest number found in birds. The first six of these *vertebræ* in the Toucan are articulated by ball-and-socket joints, the ball and the socket being most distinct in the last two joints. That between the sixth and the ankylosed *vertebræ* is provided with a capsule and synovial fluid; the others have a yielding ligamentous mode of connexion. The spinous processes of these *vertebræ*, both superior and inferior, are of moderate size, but smallest in the sixth, where the greatest degree of motion takes place. The transverse processes, on the contrary, are large and broad, so as almost wholly to prevent lateral motion. The first of the ankylosed *vertebræ* is broad and flat and of a rounded form, supporting the two coccygeal glands: the last of these processes is compressed laterally, and of the ordinary ploughshare form. The caudal *vertebræ* can be inflected dorsad till their superior spines are brought into contact with the *sacrum*; in the opposite direction they can scarcely be bent beyond a straight line: and it is to this structure of the bones and joints that is to be attributed the capability in the Toucan of turning its tail upon its back (as represented in the Zoological Journal, vol. ii. pl. xv.), the muscles presenting comparatively few peculiarities, since the motion alluded to is remarkable rather for its extent than the vigour with which it is performed.

The principal *elevators* of the tail are the *sacro-coccygei superiores* (*sacro-sus-caudiens* of Vicq d'Azyr). They arise from two longitudinal ridges on the inferior and convex part of the *sacrum*, and are inserted into the superior spines of the first six *vertebræ* by detached tendons, terminating broadly in the ankylosed *vertebræ*. The principal antagonists of these muscles, *sacro-coccygei inferiores* (*sacro-sous-caudiens* of Vicq d'Azyr), pass over the first five *vertebræ* and terminate in the sixth and ankylosed *vertebræ*: their origins are wider apart than in the preceding pair of muscles, coming off from the margins of the sacro-sciatic notches. In the interval are situated small muscles passing from the transverse processes to the inferior spines of the first six *vertebræ*.

From the limited nature of the lateral motions of the tail the muscles appropriate to these movements are feeble, especially in comparison with those which are observed in the birds that spread their tail-feathers

in flight, in order to regulate their course during that vigorous species of locomotion. These muscles are in number two on each side, arising from the posterior extremities of the *ischia*, and inserted into the expanded anchylosed *vertebræ*. From the disposition of these muscles it is obvious that after the proper *elevators* have raised the tail to a certain height, they also become dorsad of the centre of motion, combine their forces with the *elevators*, and by this addition of power terminate the act of throwing up the tail by a jerk: Mr. Vigors in his observations on the living animal observes, that "in these movements the tail seemed to turn as if on a hinge that was operated on by a spring."

The osseous portions of the mandibles of the Toucan are disposed in a manner adapted to combine with the great bulk of those parts a due degree of strength and remarkable lightness, and the bony structure is consequently of a most beautiful and delicate kind. The external parietes are extremely thin, especially in the upper beak: they are elastic, and yield in a slight degree to moderate pressure, but present considerable resistance if a force is applied for the purpose of crushing the beak. At the points of the mandibles, the outer walls are nearly a line in thickness; at other parts, in the upper beak, they are much thinner, varying from 1-30th to 1-50th part of an inch, and in the lower beak are from 1-20th to 1-30th of an inch in thickness.

On making a longitudinal section of the upper mandible, its base is seen to include a conical cavity, about two inches in length and one inch in diameter, with the apex directed forwards. The walls of this cone consist of a most beautiful osseous network, intercepting irregular angular spaces, varying in diameter from half a line to two lines. From the parietes of this cone, a network of bony fibres is continued to the outer parietes of the mandible, the fibres which immediately support the latter being almost invariably implanted at right angles to the part in which they are inserted.

The whole of the mandible anterior to the cone is occupied with a similar network, the meshes of which are largest in the centre of the beak in consequence of the union which takes place between different small fibres as they pass from the circumference inwards. It is remarkable that the principle of the cylinder is introduced into this elaborate structure: the smallest of the supporting pillars of the mandibles are seen to be hollow or tubular, when examined with the microscope. The structure is the same in the lower mandible, but the fibres composing the network are in general stronger than those of the upper mandible.

The medullary membrane lining these cavities appears to have but a small degree of vascularity. Processes of the membrane, accompanying vessels and nerves, decussate the conical cavity at the base of the beak. The principal nerves are two branches of the fifth pair, which enter at the lower part of the conical cavity, and diverge and ascend as they pass forwards to the end of the bill, giving off branches, which are distributed to the horny covering, and supply it with sensibility.

The air is admitted to the interior of the upper mandible from a cavity situated anterior to the orbit, which communicates at its posterior part with the air-cell continued into the orbit, and at its anterior part with the maxillary cavity. The nasal cavity is closed at every part, except at its external and internal apertures, by the pituitary membrane, and has no communication with the interior of the mandible.

The organ of smell is confined to the base of the upper jaw. The canal, which is traversed by the air and odorous particles in inspiration, forms a sigmoid curve in the vertical direction. The external orifice is on precisely the same perpendicular line as the internal one. It is situated at the posterior surface of the upper mandible, where it is raised above the level of the cranium; the orifice is consequently directed backwards, secure from all injury that might happen to it in the act of penetrating dense or interwoven foliage.

The olfactory canal is at first of almost a cylindrical form, and about two lines in diameter. It passes forwards for about half an inch, receiving from the mesial aspect the projection of the first spongy bone; it then bends downwards and backwards, and is dilated to admit the projections of the two other spongy bones: from this point it descends vertically to the palate, at first contracted, and afterwards dilating to form the internal or posterior orifice. The first or outermost spongy bone is almost horizontal, and has its convexity

directed outwards. The second is nearly vertically placed, with its convexity directed backwards: it terminates in a narrow point below. The third or superior spongy bone makes a small projection towards the mesial plane, about the size of a pea. These spongy bones are formed by inward projections of the inner and posterior osseous parietes of the nasal passage; they are cellular, and air is continued into them from the cranial diploë; but the parietes of the nasal passage are entire and smooth, and lined by a delicate pituitary membrane. The inner table of the skull is continuous with the parietes of the nasal cavity, by means of the bony canal which accompanies and protects the olfactory nerves, and which represents, as it were, a single foramen of the cribriform plate of the mammalia. The communication of the cavity of the cranium with that of the nose is thus similarly formed, and is only obstructed in the recent state by the pituitary membrane, on the posterior *cul de sac* of which the olfactory nerve distributes its branches in a radiated manner. These branches were confined, as Scarpa has observed in other birds, to the pituitary membrane covering the septum narium and the superior spongy bone.

The external orifice of the meatus auditorius is situated about half an inch behind the lower boundary of the orbit. The membrana tympani closes it so obliquely that its plane is directed almost backwards; its anterior edge is consequently about three lines from the external orifice, while its posterior margin is at least six lines from the same point. It is convex outwardly as in birds generally. The apparatus of the internal ear is easily exposed, the semicircular canals being lodged in a delicate reticulation of the diploë of the cranium. These parts, with the ossiculum of communication and the cochlea, do not present any deviations from the ordinary structure worthy of notice.—R. O.

DESCRIPTION OF THE PLATE.

Fig. 1. Section of the cranium and upper mandible of the *Rhamphastos Toco*.

- a. The cancellated structure of the beak.
- b. The cavity at the base.
- c. Branches of the fifth pair of nerves.
- d. The external orifices of the nostrils.
- e. The osseous parietes of the nasal passages.
- f. The osseous tubes protecting the olfactory nerves.
- g. The pituitary membrane exposed, and branches of the olfactory nerve radiating upon it.
- h. The superior semicircular canals of the internal ear.
- i. Hemispheres of the cerebrum.
- k. Cerebellum.

Fig. 2. The upper surface of the tongue.

- l. The fringed or feathered portion of the tongue.
- m. The orifice of the larynx.
- n. The orifice of the pharynx.

- o. Cornua of the os hyoides (*cerato-hyal* bones of Geoffroy).

- p. The trachea, or windpipe.

- q. The gullet.

Fig. 3. Vertical longitudinal section of the head.

The same letters indicate the same parts as in the previous figures.

- d. Shows the internal aperture of the nostrils.

- r. The beginning of the spinal chord.

- s. The articulating surface of the occipital bone.

- t. The nasal septum or partition.

- u. The air-cell anterior to the orbit from which the air passes into the mandible.

- v. The cancellated structure of the lower jaw.

Fig. 4. Side view of the foot of *Ramphastos Toco*.

Fig. 5. Under surface of the same.

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