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MEMOIRS
ON THE
EXTINCT WINGLESS BIRDS OF NEW ZEALAND;
WITH AN APPENDIX
ON THOSE OF
ENGLAND, AUSTRALIA, NEWFOUNDLAND, MAURITIUS, AND RODRIGUEZ.

BY
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VOL. I. TEXT.

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PREFACE.

The advantage of attention to any object of Natural History, however unattractive, if it be not a recognizable or previously known specimen, is exemplified in the fragment of bone (Plate, p. 73) which is the foundation of the present work.

It was brought for sale to the College of Surgeons in 1839 by an individual who stated that he had obtained it in New Zealand from a native, who told him that it was the bone of a great Eagle; and for this specimen he asked the sum of ten guineas.

I assured him that he had been misinformed; that the specimen had not the structure of a bone of such a bird of flight; that it was a marrow-bone, like those brought to table wrapped in a napkin.

To further questions as to its locality the vendor replied by showing, amongst other evidences, a jadestone weapon peculiar to the New-Zealanders, which he had also brought from the island, and still seemed to attach so much value to the unpromising fragment, that I consented, being at the time specially engaged, to try to make out the bone if he would leave it with me and call for it the next day.

As soon as I was at leisure I took the bone to the skeleton of the ox, expecting to verify my first surmise; but, with some resemblance to the shaft of the thigh-bone, there were precluding differences. From the ox's humerus, which also affords the tavern delicacy, the discrepancy of shape was more marked. Still, led by the thickness of the wall of the marrow-cavity, I proceeded to compare the bone with similar-sized portions of the skeletons of the various quadrupeds which might have been introduced and have left their remains in New Zealand; but it was clearly unconformable with any such portions.

In the course of these comparisons I noted certain obscure superficial markings on the bone, which recalled to mind similar ones which I had observed on the surface of the long bones in some large birds. Thereupon I proceeded with it to the skeleton of the Ostrich. "The bone" tallied in point of size with the shaft of the thigh-bone in that bird, but was markedly different in shape. There were, however, the same superficial reticulate impressions on the Ostrich's femur which had caught my attention in the exhaustive comparison previously made with the mammalian bones.

In short, stimulated to more minute and extended examinations, I arrived at the conviction that the specimen had come from a bird, that it was the shaft of a thigh-bone, and that it must have formed part of the skeleton of a bird as large as, if not larger than, the full-sized male Ostrich, with this more striking difference, that whereas
the femur of the Ostrich, like that of the Rhea and Eagle, is "pneumatic," or contains air, the present huge bird's bone had been filled with marrow, like that of a beast.

When its owner called the next day I told him, with much pleasure, the result of my comparisons, and assured him that I would recommend the purchase of the bone, at the price asked, to the "Museum Committee."

I regret to relate that, notwithstanding my testimony, the purchase of the unpromising fragment was declined; and it was not convenient to me, in 1839, to pay the sum out of my own pocket. I promised, however, to commend the specimen to other possible purchasers, one of whom I found, through my friend Mr. Broderip, F.R.S., in Benjamin Bright, Esq., then M.P. for Bristol.

Meanwhile the vendor permitted me to make the drawings which are lithographed in the Plate, p. 73; and these drawings, with my descriptions and conclusions, were submitted to the Zoological Society of London, November 12th, 1839.

I was not surprised that there was some hesitation in the "Publication Committee" as to the admission of the Paper with the Plate into the 'Transactions.' The bone was not fossilized; it might have come from a kind still existing. But a bird larger than an Ostrich, belonging to a "heavier and more sluggish species," could hardly have escaped observation in so limited a tract of dry land as New Zealand.

Moreover, after arriving at the conviction that "the bone" was part of a huge terrestrial bird, I still felt some uncertainty as to the alleged "habitat."

At that date the largest known land-bird of the islands of New Zealand was the Apteryx; and even its existence had begun to be doubted. Accordingly the Earl of Derby, then President of the Zoological Society, who possessed the unique skin which had been brought by Captain Barclay from New Zealand in 1812, and had been figured by Dr. Shaw in his 'Naturalist's Miscellany,' transmitted the specimen to the Society, and confided it for re-examination and description to William Yarrell.

Now this bird was barely the size of a Pheasant; and "the bone" indicated a bird as big as an Ostrich.

But the Ostrich has the continent of Africa for its home; the Rhea roams over South America, the Emu over Australia; Casuarius has not only New Guinea but North Australia, and some neighbouring islands, as its "habitat."

1 For the acquisition, many years later, of this specimen by the British Museum, see p. 149.
3 Temminck, in his 'Analyse du Système Général d'Ornithologie,' relegates the Apteryx and Didus to a terminal group under the name of "Inertes;" and Lesson asks:—'L'Apteryx de M. Temminck ne seroit-il pas fondé sur les pièces de Dronte [Dodo] conservées au Museum de Londres?" ('Manuel d'Ornithologie,' vol. ii. p. 211.)
The misgivings of Vigors and some other of my zoological contemporaries were as to the possibility of a terrestrial bird, of the size I supposed, having been able, at any time, to find subsistence in so small a tract as New Zealand.

That island, moreover, had been visited by accomplished naturalists; and the only evidence of a wingless bird which they had been able to obtain there, were fragments and feathers of a small one called "Kiwi-kivi" by the natives, who hunted it by night with torches and dogs. M. Lesson accordingly refers the evidences of this bird brought from New Zealand by the circumnavigatory vessel 'La Coquille,' in 1828, to the *Apteryx australis* of Shaw. Similar evidence is given by M. D'Urville and MM. Quoy and Gaimard.

The interpretation of a single fragment of bone seemed to my more experienced seniors too narrow a foundation for the inference "that there had existed, if there does not now exist, in New Zealand, a struthious bird equal in size to the Ostrich." Nevertheless I urged that it was not an Ostrich, consequently not any then known species of bird, and that it might as well have come from New Zealand as anywhere else.

Ultimately the admission of this paper into the 'Transactions,' with one plate, was carried at the Committee, the responsibility of the paper "resting exclusively with the author."

On the publication of the volume in 1838, one hundred extra copies of the paper were struck off; and these I distributed in every quarter of the islands of New Zealand where attention to such evidences was likely to be attracted.

In this distribution I was efficiently aided by Colonel William Wakefield, at that period zealously carrying out in New Zealand the principles of colonization advocated by his brother Mr. Edward Gibbon Wakefield; by J. R. Gowen, Esq., a Director of the then recently established "New-Zealand Company;" by my friend Sir William Martin, the first Chief Justice; and by the Right Rev. Dr. Selwyn, the first Bishop of the islands.

The confirmatory response, anxiously expected through the years 1840, 1841, and 1842, at length arrived, in the letter from the Rev. William Cotton, M.A., in that from Colonel Wakefield, cited at p. 109, and in the collections of bones transmitted by the Rev. William Williams, and received in 1843 by the Rev. Dr. Buckland, at Oxford, and by Dr. (afterwards Sir John) Richardson, at Haslar Hospital.

These specimens, generously confided to me for description, form the subject of the

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1 Zoologie de la Coquille, tom. i. p. 418.
2 Voyage de l'Astrolabe, tom. ii. p. 480 (1832).
3 *Ib. Zoologie.* "Il nous a été impossible de nous procurer le singulier oiseau qu'a figuré Shaw sous le nom d'*Apteryx australis*. Nous avons rapporté le manteau d'un Chef qui était recouvert des plumes de cet oiseau que les Zélandais de la Baie Tolaga connaissent sous le nom de 'Kiwi'" (tom. i. p. 158).
paper communicated to the Zoological Society, November 28th, 1843, and of the first "Memoir on the Genus Dinornis" in the present work.

To this Memoir is prefixed one "On the Anatomy of the Apteryx," which, notwithstanding the inferiority of size, modified structure of the palate, and different proportions of the beak (compare Pl. VII. fig. 2, with Pl. CXIV. fig. 1), is the living bird which is the nearest of kin to the extinct Moas.

As expressions in the present collection of "Memoirs" occasionally occur on ornithological problems which have since been solved, notes of the dates of such papers may here be given.

Page 1, containing the remark on the Dodo, was printed in 1838; p. 41, on the skin-muscles of Birds, in 1842. In the "Memoir on the Genus Dinornis" of 1843, p. 73, reference is made to the initial paper of 1839. Since that date materials for the present volume have reached me year by year, and have received such notice as I deemed might stimulate to further research.

That the bird I had pictured in imagination, and afterwards, on acquiring sufficient evidence of specific characters, called Dinornis struthiödes, was not the sole representative of its genus, and was far from being the largest, were facts for which I was not prepared. It has been some satisfaction to me to find that eminent ornithologists have recently added one or two species to the Rhea americana; and one may well imagine that the more numerous and diversified kinds of Dinornis exhibited as well-marked superficial characters as are shown by the six admitted living species of Casuarius, the osteological distinctions of which are less marked than those on which I have founded fifteen species of Dinornis.

I here repeat my hearty thanks to the contributors of the subjects of the several Memoirs in which those species are characterized, and acknowledge my deep obligations to the Zoological Society of London for the favourable medium of making known successive discoveries of the extinct Birds of New Zealand in their 'Proceedings' and 'Transactions,' and for the liberal permission to avail myself of the plates given in those publications for the purpose of the present work.

With pleasure, also, I embrace this opportunity of expressing my sense of the value of the co-operation of my friend Mr. James Erxleben, the accomplished Artist to whom this work owes the chief part of its Illustrations.
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**ERRATA.**

Page 109, *for* Plate XVIII. *read* Plate XVII.

110, *for* Plate XVIII A. *read* Plate XVIII.

111, *for* Plate XVIII A. *read* Din. casuarinus.

111, 11 lines from bottom, *for* young *Dinornis struthioides* read *Dinornis casuarinus.*

112, 4 lines from top, *for* Dinornis read Aptornis.

112, 12 lines from top, *for* Dinornis read Aptornis.


459, 10 lines from top:—My friend and valued correspondent, Lady Martin, wife of the first Chief Justice of New Zealand, writes to me, "I am surprised to see 'taiaha' translated as 'axe' or 'adze.' We have seen and handled many 'taiahas,' and always heard the name given to a wooden spear. These spears were often well carved. An axe is ordinarily called 'toki.'"

459, line 13, *for* "panetao" *read* "pounamu."

459, line 20, *for* "tutal" *read* "tutai:" the Maoris have no l sound.
MEMOIR
ON THE
APTERYX AUSTRALIS.

IF the Apteryx of New Zealand were to become extinct and all that remained of it after the lapse of one or two centuries for the scrutiny of the Naturalist were a foot in one Museum and a head in another, with a few conflicting figures of its external form,—one representing it in the attitude of a terrestrial Bird, another, like that in Dr. Shaw's Miscellany\(^1\), portraying it erect, like a Penguin\(^2\),—the real nature and affinities of this most remarkable species would be involved in as much obscurity, and would doubtless become the subject of as many conflicting opinions among the Ornithologists of that period, as are those of the Dodo at the present day.

That the opportunities of acquiring a knowledge of the organization of the extinct Bird once inhabiting the island of Mauritius should be now irrevocably past, is, I need not say, a subject of the deepest regret to every one interested in the advancement of zoological science: whether he be engaged as a systematic naturalist in unravelling the intricacies of the natural system; or as a physiologist, in determining the relations which subsist between structure and habits; or as a philosophical anatomist, in investigating the principles which regulate the deviations from a typical standard of organization, and which always receive their most striking illustrations from the aberrant forms at the confines of a great natural group.

The aim of the present memoir is to prevent the recurrence of similar regrets in reference to the A* * p* * e* * r* * y* * x A* * u* * s* * t* * r* * a* * l* * i* * s*, by securing, before its extinction, a record of its organization, adequate to the several applications above-mentioned.

In the year 1833 the only part of the Apteryx which existed in Europe was the stuffed skin in the Museum of the Earl of Derby; this was the original specimen on which the genus was founded by Dr. Shaw\(^3\); but many years having elapsed without any additional evidence of the bird having reached Europe, it began to be questioned, as in the case of the Dodo, whether the species had ever existed. At this time the original and unique specimen of the Apteryx was transmitted to the Zoological Society and submitted to the free inspection of the Members by their Noble President, and the results of a minute and accurate examination of this precious evidence of the rarest and most sin-

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\(^1\) Naturalist's Miscellany, pl. 1057, 1058, vol. xxiv. 1813.
\(^2\) Whence the name of A* * p* * e* * r* * y* * x P* * e* * n* * q* * u* * i* * n* * applied to the A* * p* * e* * r* * y* * x by Dr. Latham, General History of Birds, vol. x. p. 394.
\(^3\) Loc. cit.
gular of Birds were recorded by Mr. Yarrell in the first volume of the Transactions of the Zoological Society\(^1\).

Mr. Yarrell at the conclusion of his excellent description expresses “a hope, that the zeal and liberality of the numerous friends and corresponding members of the Society in that part of the globe inhabited by the Apteryx directed to the attainment of this object will yet be successful, and enable us at some future period, perhaps not far distant, to supply the deficiencies which at present exist in our knowledge of the natural history of the Apteryx\(^2\).” This hope has been fulfilled, and the appeal made by the able ornithologist just quoted has been satisfactorily responded to.

The same Noble Cultivator and Patron of zoological science, to whom Ornithologists are indebted for the means by which the true external characteristics of the *Apteryx australis* have been established, has also liberally contributed the materials on which has been founded the chief part of the account of its internal anatomy contained in the present memoir.

The trunk of a male *Apteryx* containing the *viscera*, and extremely well preserved for anatomical investigation, was transmitted by the Earl of Derby for that purpose to the Zoological Society in March 1838. Some months afterwards the abdominal *viscera*, with the bones and tendons of the feet of a female *Apteryx*, were liberally presented to me by Dr. Logan, R.N., through the friendly intercession of Sir Wm. Hooker. Subsequently I received the entire body of a male *Apteryx*, preserved in spirits, from my esteemed friend Mr. Geo. Bennett of Sydney, N. S. Wales, a zealous and valuable Corresponding Member of the Zoological Society. These are the materials from which the following descriptions have been taken.

The *Apteryx* presents such a singular and seemingly anomalous compound of characters belonging to different orders of Birds, as may well make the naturalist pause before he ventures to pronounce against the possibility of a like combination of peculiarities in the historical Dodo. It seems, as it were, to have borrowed its head from the Longirostral *Grallæ*, its legs from the *Gallinæ*, and its wings from the *Struthious* order. It is clothed with a plumage having the characteristic looseness of that of the terrestrial birds deprived of the power of flight; its feathers resemble those of the Emeu in the general uniformity of their size, structure, and colour, but they are more simple than in any of the tridactyle *Struthionidæ*, as they want the accessory plumelet\(^3\). The skin of the *Apteryx* is remarkably thick and strong as compared with that of most other birds; it is fully a line in thickness along the back, and gradually diminishes to half a line along the under part of the neck and trunk. A great quantity of fat, of the

\(^1\) Description, &c. of the *Apteryx Australis* of Shaw, by W. Yarrell, F.L.S., Zool. Trans. i. p. 71. 1833.

\(^2\) *Loc. cit.* p. 75.

\(^3\) Pl. I. fig. 5.
soft oily kind usually found in Birds, is accumulated beneath the skin along each side of the spine, about the rump, beneath the abdomen, and more especially in front of the sternum, where it fills up the depression below the root of the neck, which is occupied by the crop in the Gallinaceous Birds. These prépectoral masses of fat are supported by a muscle arising from the sternum and expanding over the sternal aspect of the neck: there is no fat deposited beneath the skin covering the rest of the neck; this thinner integument adheres through the medium of a close cellular tissue to a cutaneous muscle with transverse fibres, which surrounds the whole of the neck, and will be subsequently described.

When the trunk is stript of its plumage, the body of the Apteryx presents the form of an elongated cone gradually tapering forwards, from the broad base formed by the haunches, to the extremity of the attenuated beak. The wings appear as two small crooked appendages projecting about an inch and a half from the sides of the thorax, and terminated by a curved, obtuse, horny claw, three lines long: the antibrachium is retained in a state of permanent flexion by the surrounding integument of the wing; and it cannot be brought by forcible extension beyond an angle of 45° with the humerus. Nine quasi-quill-plumes, not exceeding in length the ordinary body-feathers, but with somewhat thicker shafts, are arranged in a linear series along the ulnar margin of the antibrachium; the terminal ones are the largest, and in one specimen they presented a structure differing from that of the ordinary plumes, consisting of a shaft, from which radiated a series of flattened horny filaments of nearly equal length.

The podotheca commences just above the ankle-joint (suffrago) by the development in the cuticle of small scales (squamae); these are smallest at the bend of the joint, where they are arranged in transverse rows; they increase in size as they descend, and at the eighth, ninth, or tenth row the two middle scales begin to enlarge and assume the character of scutulae: a row of these scutulae extends down the fore part of the tarsus; most of them are bipartite, but a few are entire: a double row of smaller scutulae extends down the middle of the back part of the tarsus, as far as the base of the innermost toe: the rest of the podotheca is formed by a reticulation of scales, somewhat larger on the inner than on the outer side. There is a large convex plantar cushion just behind the divergence of the three anterior toes: these differ from the toes of the typical Gallinae in not being connected at their base by an intervening membrane; they are on the contrary quite free, as in the tridactyle Struthionidae; a row of entire scutulae extends along the upper surface of each toe; the sides and under part are covered with small rounded scales, which diminish in size to the ends of the toes. The length of the tarsus and of the toes in the largest male specimen of the Apteryx, transmitted to me in spirits, corresponds with that of the specimen described by Mr. Yarrell; the tarsus being 3 inches in length, the middle toe 2 inches 4 lines, the lateral ones each 1 inch and 5 lines.

The head of the Apteryx is broad, slightly depressed, and very regularly convex above.

1 Pl. I. fig. 4.
The opening of the eyelids is situated immediately behind the vertical line touching the angle of the gape, and about three lines above that angle; it is 4 lines in length: the lower lid is most developed, as in other birds; the upper one is fringed with a row of pretty stiff black cilia. The external auditory aperture is situated half an inch behind the eye, and is also a horizontal elliptical fissure, 4 lines in length, formed by a tumid fold of integument, and defended by short and strong ciliiform plumelets.

The weight of the male Apteryx transmitted to me by Mr. Bennett, and which had all the appearances of a mature bird, was, without its plumage, 3 lbs. 6 oz. 12 dr. avoirdupoise; its total length, from the extremity of the beak to that of the outstretched leg, was 28 inches and 8 lines; from the extremity of the beak to that of the coccyx, 19 inches; the length of the trunk was 7 inches; the length of the neck, head and beak included, was 12 inches; that of the beak, from the gape to the point, 4 inches and 8 lines; the breadth of the beak at the gape, 1 inch; its depth or vertical diameter at the same part, 7 lines. The different proportions of these latter dimensions to the length of the beak, as compared with those in the specimen described by Dr. Shaw and Mr. Yarrell, are considerable; the length of the beak in that specimen, from the gape to the point, being 6 inches and three quarters. This difference has led me to compare together very minutely the different specimens of the Apteryx at present in the Museum of the Zoological Society and in that of Mr. Gould, particularly with reference to the condition of the beak. Of these specimens, which are five in number, two present proportions of the beak, corresponding nearly with those of the originally described specimen¹; the other three have the shorter and weaker beak of the male Apteryx here described². The following are the admeasurements taken from these specimens:

| Dr. Shaw's | Mr. Gould's | Zool. Soc. No. 1 | Mr. Bennett's Male | Zool. Soc. No. 2 | Zool. Soc. No. 3 |
|-------|------|------|------|------|------|------|------|------|------|
| 6     | 8    | 6    | 4    | 6    | 3    | 4    | 8    | 4    | 6    |

Thus we have a series of three longer-billed and three shorter-billed specimens of the Apteryx: dissection has shown one of the latter to be of the male sex; it remains to be proved whether the longer bill is peculiar to the female. At present it may be questionable whether this difference be dependent on a difference of age, of sex, or of species. But I would observe, that on the first hypothesis it might be expected that the bill would have been smaller in all its dimensions, and that there would have been a want of correspondence in the size of other parts, as of the feet³. This, however, is not the case, but on the contrary, the very close correspondence between the short- and long-billed specimens in all other particulars indicates the difference in the length of the beak to be not a specific one. If, therefore, it should actually be found to be a sexual character, it will form another anomaly in the organization of the Apteryx; for

¹ Pl. I. Fig. 1. ² Pl. I. Fig. 2. ³ The general dimensions of Dr. Shaw's specimen being taken from a dried and stuffed skin are liable to inaccuracy; Dr. Shaw assigns to it, from the tip of the bill to the extremity of the body, about 30 inches.
I am not aware that in any other species of bird there is the same difference in the relative length of the bill, as compared with its breadth, in the two sexes.

The soft integument of the head is continued over the base of the bill, and extended along each side, in the form of a narrow angular process, as in the larger Struthious birds. The lateral and a greater portion of the upper part of this integument are covered with short stiff plumes, directed forwards, with long slender black bristles intermixed, and projecting in various directions. The naked part of this integument or *cere* presents a peculiar form, being deeply emarginate both before and behind: the middle portion measures 1½ line in the longitudinal diameter; that of each lateral portion is 9 lines: the transverse diameter of the *cere* is 4 lines; from the gape to the *apex* of the lateral process of plumed integument is 1 inch 8 lines. From this *apex* two narrow grooves extend along the side of the upper mandible, nearly parallel with the *tomia*; the upper groove is continued into a subcircular furrow sculptured on the deflected truncate tip of the mandible; the lower groove leads into the external nostril, which forms the dilated termination of this groove; the nostrils, as is well known, are most singularly situated, within one-eighth of an inch of the extremity of the slender elongated mandible.

An angular process of plumed and bristled integument, narrower than that above, extends forwards upon each side of the lower mandible to the distance of 8 lines from the gape. A groove is continued forwards from the *apex* of this process, and expands into a shallow depression as it proceeds. The lower mandible becomes gradually narrower and flatter to its *apex*; its entire length in the male was 5 inches 3 lines; each *ramus* is articulated by two trochlear cavities to two corresponding convexities on the *os quadratum*; from the posterior extremity to the point of confluence of the two *rami* measures 3 inches; from this point two linear impressions extend forwards, slightly diverging from each other, until about half a line from the tomal margin, nearly parallel with which they are continued to the end of the mandible. This part is obtusely rounded, and is opposed to the posterior concavity of the deflected and expanded tip of the upper mandible. Thus when the Apteryx rests its head upon its beak, the extremity of which then presses upon the ground,—a not unusual posture, as I am informed,—the superincumbent weight is transferred by both mandibles to their proximal extremities: when, also, the beak is thrust into the ground in quest of food, the force of both jaws is concentrated upon the smooth and dense wedge-shaped extremity of the upper mandible, and the earth is less liable to be forced between the mandibles than it would have been if the anterior opening had not been defended by the deflected tip of the upper one.

1 In other classes we meet with examples of a considerable difference in the development of the jaws as a sexual character; thus, in Mammalia the jaws of the male Cachalot have more than twice the length, both relative and absolute, of those of the female. In Insects the *Lucani* are familiar examples of a still more disproportionate development of the mandibles in the male; in the Apteryx the difference in the development of the jaws, if sexual, is the reverse, the excess being in the female, and this would correspond with the sexual superiority in size and strength in the females of the Raptorial Birds.

2 Pl. I. a. Fig. 2.

3 Pl. I. a. Fig. 1.
If the beak of the *Apteryx* be compared with that of the *Ibis* and *Rhea*, it will be found that its plan of construction is precisely that of the Struthious Bird, and that the resemblance to the grallatorial beak is confined to the elongated form and slenderness of its produced anterior part. In the *Ibis*, for example, the beak is compressed from its very commencement; in the *Apteryx* it is depressed at its base, as in the *Rhea*. There is no production of integument, either plumed or naked, upon the base of the bill of the *Ibis*, while in the *Rhea* we find precisely the same structure, but on a magnified scale, as that above described in the *Apteryx*; the naked *cere* is deeply emarginate, both before and behind; the plumed integument has many black *setæ*, but shorter and finer than in the *Apteryx*, mingled with the short and stiff feathers. In the *Ibis* the external nostrils are pierced in the very base of the beak; a groove is continued from each nostril to the end of the mandible; the same grooves are seen in the *Rhea*, but here the nostrils open at the anterior angle of the lateral processes of plumed integument, which are extended along the sides of the base of the bill, as in the *Apteryx*. In another Struthious genus, the *Cassowary*, the nostrils are situated still more forwards, and are pierced, as in the *Apteryx*, in the horny sheath of the bill itself; there is no other Bird which approaches nearer to the *Apteryx* in the anterior position of the nostrils than does the *Cassowary*; the peculiar modification of the base of the beak in this Bird obscures, as it were, the resemblance which we might otherwise have been able to trace in that part. The *Emeu* and *Ostrich* correspond with the *Rhea* and *Apteryx* in the modifications above noticed, in the base of the upper mandible. If we examine the lower mandible of the larger *Struthionidae*, we perceive a modification of its inferior surface, which distinguishes it from that of any Gallinaceous or Grallatorial Bird; in the *Ostrich* the tip is formed by a raised quadrate portion, separated by two lateral parallel grooves from the rest of the *gnathotheca*; in the *Rhea* the corresponding raised median piece is longer and narrower than in the *Ostrich*, and the lateral boundary-lines converge backwards to the angle where the *symphysis menti* commences. In the *Apteryx*, notwithstanding the modification by which the bill is transformed from a granivorous to an insectivorous instrument, we find a middle piece marked out, as in the *Rhea*, by two grooves diverging forwards from the angle of confluence of the *rami* of the jaw. The lower mandible of the *Ibis* offers no trace of this character, but is traversed longitudinally by a single mesial groove.

In the *Apteryx* a narrow membranous fold or ridge is continued from each angle of the gape obliquely forwards and inwards upon the slightly convex under or palatal surface of the upper mandible, and these ridges are gradually lost about 8 lines in front of the posterior apertures of the nostrils; these apertures present the form of two linear slits, 4 lines in length, situated close together, parallel with the axis of the beak, and 4½ inches from its extremity, in the male: the common opening of the Eustachian tubes is situated two lines behind the posterior *nares*. From the anterior part of these aper-
tures a narrow ridge is continued forwards along the middle line of the palatal surface of the beak to its deflected extremity: a mesial groove, corresponding with the above ridge, runs along the flattened upper surface of the elongated myxa of the lower mandible.

There is the same structure on the inner surface of the upper and lower mandible in the Ostrich and Rhea. In these, however, the palatal surface of the upper mandible is slightly concave; but in the Apteryx the opposed surfaces of the upper and lower mandibles produce, when pressed together, uniform and entire contact, and, as Mr. Yarrell has observed, are well adapted for compressing or crushing such substances as may be selected for food: the coadapted ridge and groove above described must add somewhat to the power of retaining such substances. To judge from the feeble development of the muscles of the jaw, and their disadvantageous place of insertion, the force of the nip of the mandibles, however, cannot be very great; and with this knowledge of the structure of the bill, I was the less surprised to find large soft-bodied Lepidopterous larvae entire in the stomach of Mr. Bennett's male Apteryx.

There are two small temporal muscles, one superficial, the other deep-seated, which cross each other obliquely: the superficial and posterior muscle is 4 lines broad and 1 inch long; it is inserted by a round tendon into the coronoid edge, and by fleshy fibres into the external depression beneath that edge, extending as far forwards only as two-thirds of an inch from the joint of the jaw. The deep-seated temporal muscle sends its fibres to be inserted more vertically into the coronoid margin. A masseter, which is connected with a remarkably strong orbicularis palpebrarum, is inserted still nearer the joint, below the fossa for the insertion of the temporal muscle, and external to it. There is a fourth muscle employed in closing the bill, having a similar direction of its fibres to those of the masseter, but situated on the inside of the temporal muscles: it extends from the pterygoid bone downwards, to be inserted fleshy into the inside of the coronoid margin of the lower jaw. This bone admits of slight protraction and retraction, the muscles performing which are the external and internal pterygoid, on each side. The external pterygoid arises by a broad and flat tendon from the pterygoid plate, external to the posterior nares, and expands as it proceeds backwards and outwards, to be inserted into the inflected posterior angle of the lower jaw. The internal pterygoid arises from the body of the sphenoid, behind the posterior nares, and contracts as it proceeds more directly outwards to be inserted into the angle of the lower jaw, above the preceding. The bill is opened by the analogue of the biventer maxillæ, which is here a stout, short, square-shaped fleshy muscle, deriving its origin from the ex-occipital process, and descending vertically, to be attached to the broad posterior angle of the lower jaw: from its close situation to the centre of motion this muscle can divaricate the tips of the mandibles about two inches. The movements of the jaw are regulated, and its joints strengthened, by several ligaments: one of these ligaments is interarticular, and passes directly between the jaw and os quadratum, in the interspace of the double condyle: another is external, and passes from the upper and outer angle
of the *os quadratum* obliquely forwards to the lower and posterior margin of the external coronoid depression: a strong posterior ligament descends from the ex-occipital process to the posterior angle of the jaw. These strong ligaments are an essential part of the mechanism of a beak which is destined to be forcibly thrust into the ground, and used in a variety of ways, to overcome considerable resistance.

The posterior expanded surface of the palate is quite smooth in the Apteryx, as in the larger *Struthionidae*, in which the ridges and *papillae*, commonly present in other birds, are altogether absent.

The tongue¹, as was conjectured by Mr. Yarrell, is short, much shorter indeed than the interspace of the united *rami* of the lower jaw; it nevertheless presents a greater relative development than in other Struthious birds. It presents a compressed, narrow, elongated, triangular form, with the *apex* truncate and slightly notched; the lateral and posterior margins entire: it is 8 lines in length, 4 lines broad at the base, 1 line across the *apex*. The anterior half consists of a simple plate of a white, elastic, semitransparent, horny substance, gently concave above; behind this part, the exterior covering, which is lost in, or blended with, the horny plate, gradually becomes distinct, and assumes the character of a mucous membrane, and is pitted with several very minute glandular *foramina*: this membrane is reflected over the posterior margin of the tongue, forming a crescentic fold, with the concavity towards the *glottis*; but here, as well as on every other part of the tongue, it is devoid of spines or *papillae*. This fold can be brought back by the retractors of the *os hyoides*, so as to cover the *glottis*; in which movement the *uro-hyal* process plays in a cellular sheath beneath the *larynx*, and its office seems to be to give steadiness to the protractile and retractile movements of the tongue. The superficial and principal protractor of the tongue represents the *genio-hyoides*, its two lateral halves being separated and removed from the *symphysis* to within an inch of the angle of the jaw, whence its fibres pass almost directly backwards, and converge, to be inserted into the extremity of the bony *cornua* of the *os hyoides*. The *mylo-hyoides* arises from the inner side of the lower jaw, commencing posteriorly about an inch from the angle, and extending forwards to within the same distance of the *symphysis*; the fibres become gradually fewer as they are placed more forwards; they meet to be inserted at a middle tendinous line posteriorly, and are separated anteriorly by a tendon about a line in breadth: these tendons are attached to the body of the *os hyoides*, and retract it: a few tendinous threads connect also the posterior margin of the muscle with the anterior part of the upper *larynx*. On the removal of this muscle two deeper-seated protractors of the tongue are brought into view; they arise by a very thin aponeurosis from near the angle of the jaw, and pass directly backwards, to be inserted into the base of the *cornua*. These muscles adhere closely to the membrane, filling up the interspace of the *rami* of the lower jaw. The cartilaginous extremities of the *cornua* of the *os hyoides* curve upwards, and terminate about a line behind the angles of the jaw.

¹ Pl. III. Figg. 1 c. & 2.
The lining membrane of the pharynx, behind the glottis, forms two elongate, square-shaped, smooth, thick, and apparently glandular folds or processes, the obtuse free margins of which project backwards, like lappels, into the pharynx; beyond which the lining membrane is produced into close-set, narrow, somewhat wavy, longitudinal folds.

The æsophagus is continued down the right side of the neck, behind and a little to the right of the trachea, through the thorax and diaphragm to the proventriculus, without forming any partial dilatation or crop.

The upper extremity of the æsophagus is rather wider than the rest of the tube, measuring from half an inch to an inch in diameter, according to its state of contraction: it gradually diminishes to a diameter which I found in one specimen to be 3, in another 6 lines, and continues, without variation of size, to the proventriculus. The æsophagus is connected somewhat closely to the trachea, and by a looser cellular tissue to the surrounding parts. The muscular coat of the æsophagus is about half a line in thickness; its external fibres are arranged circularly; its internal ones form a longitudinal stratum. The ultimate muscular fibres are smooth, slightly wavy, and reticuly intermixed, but with a definite course. The internal membrane in the contracted æsophagus is disposed in narrow and slightly wavy longitudinal rugæ, which become more close-set and strongly marked at the lower part of the canal: when viewed with a magnifying power the whole internal surface presents a delicate reticular structure. The length of the gullet is 9 inches.

The proventriculus is a narrow elongated cylindrical cavity in the axis of the æsophagus, of which it is an immediate continuation. In one specimen it measured 1 inch 2 lines in length and half an inch in diameter, in another it was 1½ inch in length and 1 inch wide. The gastric glands are developed around its whole circumference, and are closely packed together; they are narrow elongated follicles, from 1½ to 2 lines long, mostly bilobed, but sometimes more subdivided at their caecal or outer extremities. The glandular parietes of each follicle consists of minute tubuli placed at nearly right angles with the central cavity. The muscular coat covering the glands is somewhat thicker than in the membranous part of the gullet, which is chiefly caused by the increase of the outer circular stratum of fibres, by the action of which the secretion of the glands is squeezed out into the cavity of the proventriculus. The longitudinal rugæ of the lining membrane gradually subside at the entry of the proventriculus, where they run into each other, and so form a general reticulate surface, in the meshes of which the orifices of the gastric glands are situated.

The epithelium lining the glandular part of the stomach is gradually condensed towards its lower part into a cuticle, which, as it passes into the muscular compartment, assumes a brown colour and a callous hardness, and forms a stratum about one-third of a line in thickness. In the Cassowary and Emeu the proventriculus is marked off

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1 Pl. III. c. Fig. 1.  
2 Pl. IV. & V. a.  
3 Pl. V. fig. 2 & 3.
from the stomach by a circular strip of epithelium, whiter and thinner than the rest, from one to two lines in width: the structure is well shown in Plates LI. and LII. of the 'Comparative Anatomy' of Sir Everard Home. The Apteryx, though resembling these large Struthious birds in the arrangement of its gastric glands, does not participate with them in this structure. The muscular stomach\(^1\) does not present the characteristic sub-compressed shape of a gizzard, but resembles, in its regular oval-rounded form, the membranous stomach of carnivorous birds. In its contracted state it appears small for the size of the bird, not exceeding 1 inch 10 lines in length, and 1 inch 3 lines in its greatest diameter; but in the specimen in which I found the stomach distended with food it measured 2½ inches in length, and 2 inches across at the widest part. The muscular fibres are not arranged in the well-defined masses called digastrici and laterales in the true gizzard, but radiate from two tendinous centres of an oval form, measuring about two-thirds of an inch in the longest diameter. The muscular coat when contracted is thickest at the upper part of the cavity, where its depth is about 3 lines: in the bulging part at the upper end of the gizzard from which the duodenum is continued, the muscular coat is about 1 line thick. The inner surface of the contracted stomach (\(b, \text{Pl. V.}\)) presented two protuberances at its posterior part, one near the lower and the other near the upper end: the latter is so situated with respect to the cardiac and pyloric openings that it would tend more or less completely to close those openings when the circular fibres at the upper part of the gizzard were forcibly contracted. There was no appearance of these internal projections in the dilated stomach of the second Apteryx dissected by me.

A narrow pyloric passage, of about 3 lines in length, leads from the left side of the upper extremity of the muscular stomach into the duodenum\(^2\). The pylorus is defended by a transverse crescentic ridge of the lining membrane; there is no distinct sphincter. The cuticle is continued into the duodenum about 3 lines beyond the pylorus, but there is no dilatation of this part constituting a pyloric pouch as in the Emu and Ostrich.

Before proceeding with the special description of the intestinal canal, the general disposition of the abdominal viscera may be mentioned, as they appear upon removing the abdominal muscles.

The peritoneum consists of an external strong fibrous and an internal serous layer.

The abdominal cavity\(^3\) is divided by peritoneal partitions into three compartments, which contain, besides the ordinary viscera, only a little fluid; and when the thoracic cells were inflated from the trachea no air passed into the abdominal cells or their interspaces. The two upper compartments contain the right and left lobes of the liver, which are separated from each other by a strong mediastinal process of peritoneum: the ligamentum latum in Mammalia seems to be the representative of this broad process. Each hepatic cell communicates with the single large inferior compartment of the abdomen by a round aperture situated close to the ribs; this lower compartment was

\(^1\) Pl. IV. & V. \(b.\)  
\(^2\) Pl. IV. & V. \(c.\)  
\(^3\) Pl. II.
partly divided into two lateral ones by the stomach, and the omental process continued from it to the lower or posterior margin of the hepatic septum.

A great quantity of adipose matter was accumulated, in one specimen, beneath the peritoneum. The two lobes of the liver occupied as usual the anterior part of the abdominal cavity, extending from above the notches of the sternum to midway between the sternum and the cloaca. The stomach was entirely concealed by the large omental adipose process above-mentioned, by dividing which and separating the divided portions (as in Plate III. fig. 3, a, a,) as much of the stomach was exposed as projects between and beyond the lobes of the liver. The space between the stomach and cloaca was occupied by long and simple loops of intestine, extending obliquely, and nearly parallel with each other, from the upper and right to the lower and left side of the abdomen. In one specimen these loops were concealed, like the stomach, by omental processes, thickly charged with fat (b, b,) ; each loop also included between the layers of its narrow mesentery one or two thick processes of fat (c, c), except the duodenal loop, the interspace of which was occupied as usual by the two lobes of a narrow elongated pancreas, the pointed extremity of the anterior lobe of which extended freely beyond the bend of the duodenum, as represented in the figures (Pl. II. & III. fig. 3, d.). In one specimen the duodenum formed the longest and most anterior loop (e, Pl. II.). Below or posterior to it lay the first loop of the jejunum, (f, Pl. II.) and immediately below this appeared the dilated end of the rectum (g, Pl. II.). In a second Apteryx (Pl. III. fig. 3.) I found that four loops of intestine, including the duodenum, were immediately exposed by dissecting away the omental processes: on raising these loops the rectum was seen extending forwards about 2 inches along the mesial line, and then receiving the ileum and the extremities of the two cloaca. Only the anterior half of the rectum has an entire investment of peritoneum; at its posterior or lower half that membrane leaves the abdominal parietes on each side of the rectum, and gradually advances upon the anterior part of the gut.

The lobes of the liver require to be divaricated and raised, and the stomach and its omental processes to be drawn aside, in order to trace the disposition of the whole intestinal canal. The duodenal loop, which in one specimen was about 4 inches, in another 5 inches in length, extends in a curved direction from the stomach to the right side of the abdomen, curves obliquely across the lower surface of the abdomen to the posterior and left side, and returns upon itself: the anterior half of this loop is closely attached to the other coils of the intestine; the rest of the duodenum is suspended freely in the abdomen. The intestine, after having formed the duodenal loop, bends abruptly upon itself backwards and to the right, and then forms a second loop, 3½ inches long, which continues straight down the right side of the abdomen; its extremity is seen at Pl. III. fig. 3, f. Three similar but somewhat shorter loops are then formed to the left of the preceding, after which the intestine returns to near the commencement of the duodenum, behind the stomach and close to the root.
of the mesentery, whence it descends to form a fifth long loop, situated at the left side of the abdomen, behind the others, and then becoming looser, after a short convolution, terminates in the rectum. The cæca in one specimen measured each five, in another six inches in length; they are attached to the last folds of the ileum: their tunics are thinner than those of the rest of the alimentary canal. The adipose processes developed beneath the peritoneum investing the ileum and cæca, are smaller and more detached than those connected with the preceding intestinal loops, and assume the appearance of "appendices epiploicae".

In one Apteryx I found a very short cæcum,—the remnant of the ductus vitello-intestinalis,—attached to about the middle of the small intestine; and in the viscera of the small female Apteryx transmitted to me by Dr. Logan, there extended from the same relative position of the intestinal tube an obliterated duct three lines in length, which expanded into a still persistent vitelline sac of a subglobular form, about an inch in diameter, but collapsed and with wrinkled parietes. These presented a moderate degree of thickness in the moiety of the sac next the duct, but became gradually thinner to the opposite side. The interior of the sac was lined with a stratum of a yellowish substance resembling adipocere, and contained many small wavy filamentary vessels, converging to the commencement of the duct, and evidently remains of the vasa lutea. A small branch from the mesenteric artery, the remnant of the omphalo-mesenteric, and a minute corresponding vein, accompanied the pedicle of the sac (Pl. V. fig. 1, s, t.).

In the large male Apteryx the intestinal canal measured four feet, independently of the cæca, which were each six inches in length: the rectum was four inches long.

The general diameter of the small intestines in the specimen first dissected was three lines; in the male Apteryx with the full stomach their diameter was five lines: they slightly diminish in size as they approach the rectum. In the duodenum the mucous membrane is beset with extremely fine villi, about one line in length; towards the end of the duodenum these villi are converted into thin zigzag longitudinal

1 These processes and the return of the small intestine, in the latter part of its course, to the duodenum and root of the mesentery, give to the part continued thence to the rectum a resemblance to the colon in Mammalia. The learned Editor of the excellent edition of Cuvier’s Leçons d’Anatomie Comparée, now in course of publication, is disposed to consider all that part of the small intestine which intervenes between the single vitelline cæcum (in those birds which have it) and the double ordinary cæca, as representing the colon: and the analogy of the colon of the Hyrax, which is similarly bounded at its commencement by a single cæcum, and at its termination by a double one, is undoubtedly very close. If, however, we are guided by the analogies afforded by the other oviparous classes, with which birds present so close a conformity of general structure, and in which the colon is always short, wide, generally straight, and in some, as Python, Testudo, Iguana, marked off, or commencing by a single cæcum, as in Mammalia, there can be no question in that case but that the part of the intestinal canal in Birds corresponding to the colon of Reptiles, is that which succeeds the entry of the two cæca, and which, from its shortness and straightness, is usually called the rectum. In the Ostrich, however, it is long and convoluted, and is provided with transverse valvulae conniventes. A similar structure in a less degree is present in the colon of the Iguana.

* Pl. IV. d.
folds, which are continued, but with gradually diminished breadth, to the end of the ileum. The caeca', at their commencement, are wider than the ileum, and go on slightly increasing in capacity to near their blind extremities, where they suddenly taper to an obtuse point. The diameter of each caecum, at its widest part, was five lines in the first, and six lines in the second dissected Apteryx. To the naked eye the lining membrane of the caeca presents a smooth surface; viewed with a lens, it is disposed in very fine longitudinal zigzag lines, which are replaced towards the extremities by very minute points. The lining membrane of the rectum is beset with minute short villi or points, together with glandulae solitariae, which become numerous and large at the terminal half of the rectum²: the lining membrane of this intestine, when it is contracted, is thrown into longitudinal folds; but there is no trace of the transverse or spiral valvulae coni- ventes which so peculiarly characterize the caeca and rectum of the Ostrich and Rhea: in this respect the Apteryx resembles the Cassowary and Emeu. The rectum communicates with the uro-genital dilatation by a small semilunar aperture, which, when contracted, appears as an oblique fissure, and from the produced valvular margin of which several short rugæ radiate. The urinary compartment of the cloaca is not expanded into a large receptacle as in the Ostrich, but offers the same proportional size as in the Emeu and Cassowary: it measures about two-thirds of an inch in length and the same in diameter. The ureters terminate by oblique valvular apertures³ immediately beyond the above-mentioned membranous fold, at the back part of the cavity, and about two lines apart. The vasa deferentia terminate, as in other Struthious birds, by two elongated papillæ⁴ nearer the anterior part of the uro-genital cavity. This cavity is separated from the external compartment of the cloaca by a broader and stronger fold than that which divides it from the rectum, and the angles of this fold are lost upon the sides of the penis⁵, which projects into the external compartment of the cloaca. This compartment is continued behind the uro-genital passage in the form of a large and wide bursa Fabricii⁶, which, in the larger Apteryx dissected by me, was partly divided by a crescentic vertical fold, extending forwards from its upper and back part.

The stomach, in Lord Derby's Apteryx, contained only a greenish-yellow pulpy substance, and numerous filamentary bodies, amongst which were some legs of insects and a few pebbles. The small intestines were contracted, and contained only a little pulpy material like that in the gizzard, but of a darker colour. The caeca were distended with a greater quantity of a similar but more fluid matter, in which parts of the legs of insects, apparently orthopterous, were again discernible. In the male Apteryx transmitted by Mr. Bennett, the stomach was distended with insects of various orders, which seemed to have been recently swallowed. There were four larvæ, between two and three inches in length, belonging to some species of the Lepidopterous order, probably of subterraneous habits; five larvæ of some of the Scarabeideæ, perfect; some mature Coleoptera; parts of

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¹ Pl. IV. e, e. ² Pl. IV. f. ³ Pl. IV. g. ⁴ Pl. IV. h. ⁵ Pl. IV. i. ⁶ Pl. IV. k.
small species of the Locust tribe; one *Elater*; and one Spider, quite perfect; with a few hard seeds and small pebbles. There was also some muddy fluid loaded with the black particles of the earth probably swallowed along with some of the insects. The small intestines contained portions of insects floating in a larger quantity of the black fluid: the *caeca* were distended exclusively with a thin blackish-brown pulpy fluid, in which only extremely minute portions of the legs of insects could be detected.

The *liver*, in the larger male *Apteryx*, weighed 7 drachms, 35 grains, avoirdupois; it consisted, as usual, of two large lobes, connected by a narrow isthmus, with their thin anterior edges advancing forwards on each side of the *proventriculus*, and meeting in front and a little to the left of the middle line. The right lobe is the longer, of a sub-triangular figure; the left is of a subquadrate form. The two lobes are even and smooth on their posterior and outer surfaces, but present irregular furrows and projections on their inner surface. They are traversed here transversely by a broad portal fissure occupied by the vessels and ducts. In two of the specimens there was a gall-bladder, as in the *Emeu* and *Cassowary*; in the third it was wanting, as is usually the case with the *Rhea* and *Ostrich*. In the large male the gall-bladder adhered by its whole length to the omental process covering the stomach; in the other *Apteryx* it was free, and depended by its *cervix* from the inner margin of the right lobe of the liver; in this specimen it was an inch and a half in length, and received two short cyst-hepatic ducts at its *cervix*, each nearly a line in diameter: these ducts, with the serous membrane reflected upon them, and the nutrient vessels of the gall-bladder, formed the only medium of connexion between the gall-bladder and the liver. A cystic duct was continued, in length rather more than two inches, to half-way between the lower bend and the termination of the *duodenum*. The hepatic duct is formed by two branches, one from each principal lobe, which unite together to the left of the cystic duct; it runs parallel with, and terminates a few lines below the cystic: both ducts are longer than usual. The lining membrane of the gall-bladder presents chiefly longitudinal *rugæ*, with smaller transverse lines in the interspaces. In the *Apteryx* without a gall-bladder there were two long ducts terminating in the same part of the *duodenum*; of which the one corresponding to the cystic (Pl. V. o, fig. 1.) was very slightly dilated at its origin, where it was formed by the confluence of two ducts.

The *pancreas* (Pl. IV. & V. q, fig. 1.) consisted, as usual, of two elongated subtrihe-dral lobes, lodged chiefly in the anterior part of the duodenal interspace. One of the lobes extended upwards and to the right as far as the spleen. The secretion was carried by two short and thick ducts, which terminated, close to the hepatic and cystic, and alternating with them upon a small longitudinal ridge of the duodenal lining membrane.

The spleen in one *Apteryx* was about the size and form of a hazel-nut (Pl. IV. r.); in the large male with the full stomach it was smaller and flatter: it was round, and an

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1 I am indebted to Mr. Waterhouse for the determination of the above insects.
2 Pl. IV. l.
3 Pl. IV. m.
4 Pl. IV. n.
inch in diameter in the specimen without the gall-bladder. In the larger Struthionidae the organ generally presents a longer and more compressed figure.

In considering the physiological relations of the structures which have just been described, we shall be able to trace the same interesting correlation between their different modifications and the nature of the organic substances which it is their office to assimilate, as is illustrated in other known and more striking peculiarities in the digestive organs of birds. Animals which are destined to subsist exclusively on insects usually present the chief prehensile and preparatory parts of the digestive system, whether it be the beak, as in the Ibis, or the tongue, as in the Ant-eaters and Woodpecker, of a long and slender shape; in the present species we find a pair of Struthious mandibles lengthened out and made slender for this purpose. The beak, thus organized to seize and transmit to the gullet objects of small size, is succeeded by a muscular canal of moderate and uniform width; and the food being of an animal nature and swallowed in small quantities, with successive intervals, as it is caught, the *esophagus* is not required to be modified to serve as a reservoir, either by a general width or partial dilatation. The *proventriculus* of the Apteryx is of a small relative size as compared with that of the Ostrich; its glands are also more simple in their structure, and are not aggregated into a circumscribed mass as in the Rhea. The stomach has its muscular coat more equally but less strongly developed than in any of the vegetable-feeding Struthionidae; and the small size of the cavity, as well as the moderate strength of its *parietes*, bespeaks a structure adapted for the bruising and chymification of animal substances presenting, as do worms and the larvae of insects, a moderate resistance.

The length of the intestines and the size of the *caeca*, both of which somewhat exceed those in the slender-billed Insectivorous Waders, indicate that the Apteryx—which, by being denied the power of flight, is confined to a more restricted range in quest of food—is designed to possess every needful and practicable advantage in extracting from its low-organized animal diet all the nutriment that it can yield.

The lacteal absorbents in the Apteryx in which the digestive system before death had been actively engaged in the assimilation of a full meal of insects, were plainly visible, and in many parts of the mesentery presented an opake white colour.

There was an absorbent gland, about the size of a hazel-nut, in the mass of fat below the root of the neck.

*Circulatory and Respiratory Systems.*

The heart is surrounded by a wide and thin *pericardium*, which is attached to the concave side of the *sternum* and to the margins of the anterior wide fissure of the *diaphragm*, through which the ventricular portion of the heart protrudes into the *abdomen*, in the posterior concave interspace of the two great lobes of the liver. (Pl. VI, fig. 1, a.) It requires only that a central *aponeurosis* should have been continued from the anterior
margins of the diaphragm between the heart and liver, to have completely separated from the thorax the proper abdominal viscera, as in the Mammalia; for, as will be presently described, the respiratory organs are confined entirely to the thorax.

The heart presents the usual ornithic form of a somewhat elongated cone, terminated by an obtuse rounded apex, produced beyond the projection formed by the right ventricle. The pericardium, after being reflected upon the origins of the great vessels, passes directly from the peripheral surface of the auricles upon the ventricles, so that there are no freely projecting auricular appendages. In one Apteryx I found much fat developed in the angle between the auricles and ventricles, beneath the pericardium. The right auricle appeared, when distended, of an uncommon size. The three veins terminated in it in the usual manner, but the inferior cava has a much greater relative capacity than either of the superior cæ, in consequence of these having to return to the heart little more than the proportion of venous blood brought back by the jugular and internal thoracic veins in other birds.

The auricles of the heart do not present any peculiarity of structure which is not met with in other birds; the resemblance to the Emeu in the disposition of the valves of the right auricle is very close. The great inferior cava, (Pl. VI, b, fig. 3,) the trunk of which is extremely short, opens into the sinus venosus close to the termination of the left superior cava (c, fig. 3;) the intervening membrane is slightly produced in a valvular form: the coronary vein of the heart terminates in the left superior cava, just before it opens into the auricle. The right superior cava (d, fig. 3.) opens as usual into the upper part of the sinus. The tunics of the superior cæ are remarkably strong. The sinus is divided, as in other birds, from the proper auricle by two semilunar valves, one large and anterior, the other smaller and posterior (e and f, fig. 3.). The lower horn of each valve is fixed to the floor of the auricle, the upper or anterior horn of the anterior valve is attached to a strong muscular column, which traverses the upper and anterior wall of the auricle; the extremity of the posterior valve is in like manner continued into a muscular band from the back part of the auricle. From these attachments it is obvious that the valves, during the action of the muscular parietes of the auricle, will be drawn together, and their power to resist regurgitation into the sinus will be increased, as the action of the muscles to overcome the resistance of the contents of the auricle is greater.

The posterior valve which forms part of the boundary of the foramen ovale seems to be represented in Mammalia by the muscular ridge called the annulus ovalis; the anterior valve is obviously the analogue of that called Eustachian in Man and Mammalia.

The principal deviation from the ornithic type of the structure of the heart is presented in the valve at the entry into the right ventricle (Pl. VI, g, fig. 3.) This is characterized in birds by its muscularity and its free semilunar margin. In the Apteryx it is relatively thinner, and in some parts semitransparent and nearly membranous: a process moreover extends from the middle of its free margin, which process is attached
by two or three short chordæ tendineæ to the angle between the free and fixed parietes of the ventricle. We perceive in this mode of connection an approach in the present bird to the mammalian type of structure analogous to that which the Ornithorhynchus, among Mammalia, offers, in the structure of the same part, to the class of birds; for the right auriculo-ventricular valve in the Ornithorhynchus is partly fleshy and partly membranous. The dilatable or free parietes of the right ventricle were about \( \frac{1}{4} \)th of an inch in thickness, those of the left were \( \frac{1}{3} \)th of an inch thick.

There was nothing worthy of note in the left auricle (fig. 2 and 3 h.) or in the valves interposed between it and the left ventricle: the two membranous flaps presented the usual inequality of size characteristic of the mitral valve in birds.

The aorta divides as usual, immediately after its origin, into the ascending and descending aortæ: the ascending aorta as quickly branches into the arteriae innominateæ (d, fig. 2.), which diverge as they ascend and give off the subclavians in the form of very small branches; they are then continued, very little diminished in size, as the carotids; each carotid divides or gives off a large vertebral artery before passing out of the thorax; they then mount upon the neck, converge and enter the inferior vascular canal of the thirteenth cervical vertebra, and are continued in the interspace of the hæmapophyses to the fourth cervical vertebra: here they emerge from the subvertebral canal, and passing through the interspace of the recti capitis antici, they again diverge, and when opposite the angle of the jaw, give off occipital, internal carotid, large palatine, and other branches, as in the Emeu. The principal difference observed in the Apteryx was the equality of size in the carotids: in the Emeu I found the right carotid larger than the left.

The descending or third primary division of the aorta (k, fig. 2.) presents in the Apteryx, as in the Emeu and other Struthionidæ, more of the character of the continuation of the main-trunk than in the rest of the class, in consequence of its greater size and thicker tunics, which relate of course to the diminished supply of blood transmitted to the rudimental anterior extremities; and the increased quantity required to be sent to the powerfully developed legs. The aorta arches over the right bronchus as usual, and is continued down the thorax to the interspace of the crura of the diaphragm, through which it passes into the abdomen in a manner remarkably analogous to that which characterizes the course of the aorta in the Mammalia (Pl. VI. n, fig. 1). The Apteryx, in fact, seems to be the only bird in which the limits of thoracic and abdominal aorta can be accurately defined. But, in thus establishing this distinction, we observe a remarkable difference from the mammalian arterial system, in the fact, that some large and important branches, which in the latter are given off from the abdominal aorta, arise in the present bird above the diaphragm, through which they pass by distinct and proper apertures to the abdominal viscera which they are destined to supply. These branches are the celiac axis (Pl. VI. l, fig. 1.), and the great or superior mesenteric artery (m, fig. 1.). Besides these branches, the thoracic aorta
gives off the bronchial and intercostal arteries above the diaphragm. The latter are three or four in number, which divide and form the usual plexiform anastomoses round the heads of the ribs, with branches of the vertebral arteries; from which plexuses the proper intercostal branches are continued. The cæliac axis, having perforated the dia-phragm, divides and supplies the stomach, liver, and spleen in the usual manner. The mesenteric artery offers nothing unusual in its mode of distribution. The diaphragm is itself supplied by branches from the intercostal plexuses, and there are no proper phrenic arteries.

The first branch which the aorta sends off, after having entered the abdomen, is the spermatic artery (Pl. VI. a, fig. 1.) ; this was of moderate size in the large male Apteryx, and soon divided into two branches, which were distributed respectively to the corresponding testis and supra-renal gland.

The aorta having reached the first lumbar or sacral vertebra, sends off the femoral arteries (p, r, fig. 1.), which are of equal size with the ischiadic arteries afterwards given off. The femoral is continued outwards on each side at right angles with the aorta, sends a small branch to the upper lobe of the kidney and passes out of the pelvis, not through a notch or foramen, as in most other birds, but simply over the margin of the iliac bone. It is continued upon the thigh, covered by the wide and strong sartorius, where it divides into two principal branches, of which one is distributed to the sartorius, gracilis, vasti, and other muscles at the anterior and upper part of the thigh; and the second branch is continued to the knee-joint, where it ends by forming anastomoses with the ischiadic. The aorta next sends off a pair of renal arteries (q, r, fig. 1.) of moderate size, beyond which it may be said to resolve itself into the ischiadic (r, r,) and sacro-median arteries (s, fig. 1.). The ischiadic branches are not here, as in most other birds, the main arteries of the hinder extremities; they do not exceed the femorals in size, and are principally expended upon the muscles of the leg: they escape from the pelvis as usual by the ischiadic foramina, and are continued down the back part of the thigh external to the adductor magnus, covered at first by the broad biceps cruris, and afterwards continued between the biceps and the vastus externus to the outer side of the popliteal space: here the artery accompanies the ischiadic nerve and the strong tendon of the biceps between the two heads of the gastrocnemius externus, and through the tendinous trochlear loop connected with that muscle, where it divides, and is finally distributed as in other birds.

The sacro-median artery, after sending off a small branch to the rectum, divides into the genital or hypogastric and the coccygeal arteries.

I did not observe any modification of that condition of the venous system which usually characterizes the class of birds.

The inferior cava does not perforate the diaphragm, but enters the posterior part of the pericardium just above the anterior fissure of the diaphragm: it receives, close to its termination, the two large hepatic veins. There exists the same disposition of the
renal veins which regulates the quantity of blood transmitted to the lungs or to the liver respectively, as in other birds. This disposition has been erroneously supposed to indicate that the urine was secreted from the venous blood in birds, as in reptiles and fishes; but the end attained by the venous anastomoses in question bears a much closer relation to the peculiar necessities and habit of life of the bird, and, so far as I know, has not hitherto been explained. There is no class of animals in which there may be, at any two brief and consecutive periods of existence, a greater difference in the degree of energy and rapidity with which the respiratory functions are performed, than in birds. When the bird of prey, for example, stimulated by a hungry and an empty stomach, soars aloft and sweeps the air in quest of food, the muscular energies are then strained to the utmost, the heart beats with the most forcible and rapid contractions to propel the current of blood along the systemic arteries, and the pulmonary vessels require the greatest possible supply of blood to serve the heart with the due quantity of arterialized fluid: the digestive system, on the other hand, is in a state of repose, and we may conceive the portal circulation to be at its lowest ebb.

But when the Eagle is glutted with his quarry and reduced to a state of stupor, there is a reverse condition of the two great systems which propel the venous blood from trunks to branches: the animal functions are now at rest, while the organic powers concerned in the assimilation of the food are in full play, and the portal or hepatic circulation now demands as great a supply as did that of the lungs under the previous condition.

The venous system of the kidneys is so arranged in birds that it can be distributed either to the portal system by the mesenteric vein, or to the pulmonary system by the vena cava and right side of the heart, according to the degree of rapidity with which the pulmonary or portal systems of veins are respectively emptied, or in other words, according to the activity with which the circulation in each of these systems may be going on at two different periods. The arrangement is as follows: the venous blood of the kidney is collected into a venous reservoir or trunk extending longitudinally through the substance of the gland, and more or less subdivided at its anterior or thick part in most birds; here it communicates by one or more large anastomoses with the iliac vein, which, after a short course, unites with its fellow to form the trunk of the vena cava; at the posterior or lower end of the kidney the renal vein emerges, and after receiving some small veins from the cloaca, joins the vein from the opposite kidney, and the common trunk, thus formed, then bends forwards, enters the folds of the mesentery of the rectum, and becomes the commencement of the mesenteric veins, receiving the blood from the rectum and ceca. Thus, when the circulation of the portal system is unusually active, the current of the venous blood of the kidneys will naturally tend towards the lower outlet into the mesenteric vein; but when, on the other hand, those causes are in operation which accelerate the current of venous blood through the vena cava, we may reasonably suppose that a greater quantity of the renal blood will flow by the anterior outlets into that great channel.
In the extreme case of the raptorial bird above-quoted, the advantage of such an arrangement appears sufficiently obvious to justify the teleological hypothesis here proposed; and in the rest of the class the like benefit may result from this arrangement of the renal veins to a degree corresponding with the necessity for it which may exist.

In the Apteryx the great renal vein (s, Pl. IV.) is not imbedded in the substance, but is continued along the anterior or under-surface of the kidney, receiving the blood from the lobules of the gland by many oblique but wide openings; the venous trunks of the two kidneys anastomose, as in other birds, posteriorly, to form the commencement of the mesenteric vein (t, Pl. IV.) ; and, anteriorly, after receiving the iliac veins, they unite to form the vena cava (u), and thus complete the great circulus venosus renalis. The modifications of this part of the venous system were less important than I had been led to anticipate in a bird whose comparatively limited powers of locomotion must be attended with less partial and excessive action of the respiratory system than in birds of flight.

The organs of respiration in birds are so eminently characteristic of that class, and so obviously framed with especial reference to the faculty of aerial progression, that in the Apteryx—a bird of nocturnal and burrowing habits, and of which the wings are reduced to the most rudimental condition,—the examination of the associated modifications of the respiratory system promised to be replete with peculiar interest. It was, in fact, the first point to which I directed my attention, and having made a preparatory inflation of the pulmonary organs by the trachea, I proceeded to open the abdomen, and displaced the viscera with great care; but, as has been already stated, there was not any trace of the extension of air-cells in the interspaces of the abdominal viscera; and the whole of them having been removed, I was not less gratified than surprised to find a complete and well-developed diaphragm separating the abdominal from the respiratory cavity. This septum did not present any large openings corresponding to those by which the air is continued into the abdomen in the other Struthious birds, but was here perforated only for the transmission of the æsophagus and large blood-vessels.

The diaphragm of the Apteryx differs from that which characterizes the class Mammalia in the following points; first, in the greater relative extent of the anterior or post-sternal interspace; secondly, in the greater proportion of tendinous or aponeurotic tissue which enters into its composition; thirdly, in being perforated by three different large arteries, and not by the vena cava or splanchnic nerves; and lastly, in the different relative positions of the æsophageal and aortic openings. The plane of the diaphragm is more horizontal, or rather more parallel with the axis of the trunk, than in the Mammalia generally; but some of the aquatic species, as the Dugong, present a position of the diaphragm almost similar to that of the Apteryx.

The origins of the vertebral or lumbar portion of the diaphragm are by two well-developed crura (Pl. VI. a, fig. 1.), which are attached to slight prominences on the
sides of the last costal vertebra: these crura are almost entirely tendinous; they expand as they advance forwards, and distribute their aponeurotic fibres in a manner remarkably analogous to the disposition of the fleshy fibres of the lesser muscle of the diaphragm in Mammalia. The mesial fibres decussate in front of the aorta: the lateral ones arch outwards; the rest diverge, to constitute the great central tendon. Here they cross each other in various directions, and form distinct and regular decussations around the orifices through which the cæliac artery, with the anterior splanchnic nerve, (Pl. VI, l,) and the mesenteric artery and nerves (Pl. VI, m,), pass into the abdomen: the most notable decussation is formed by two broad bands, immediately behind the large cæophageal aperture, which is separated only by a very narrow transverse chord from the anterior fissure through which the pericardium protrudes, and the inferior vena cava passes: the two broad decussating bands expand, to form the anterior boundary of the diaphragm, and are inserted into the lateral processes of the sternum.

The muscular or costal part of the diaphragm is formed, as in the Ostrich, by a number of separate, broad, and thin fasciculi, which come off from the third, fourth, fifth, sixth, and seventh vertebral ribs, near their junction with the sternal ones: these fasciculi expand, and are gradually lost upon the dorsal surface of the aponeurotic part of the diaphragm, but do not form a continuous expanse of muscle, nor constitute the entire thickness or substance of the diaphragm at any point: they are, consequently, invisible on the abdominal side of the diaphragm; and the aponeurosis of the diaphragm, together with the almost aponeurotic cellular layer of the peritoneum, with which it is continuous, requires to be reflected inwards, as at Pl. VI, 3, B, fig. 1., to bring the digitations representing the great muscle of the diaphragm into view.

The existence of a diaphragm in a rudimental condition in birds has long been recognized: Hunter left a beautiful figure of the costal portion of the diaphragm in the Ostrich, which has been published in the second volume of the Catalogue of his Physiological Collection, Pl. XXVI. In this, as well as in the other large Struthious birds, there is also a pars vertebralis or analogue of the lesser muscle of the diaphragm, which rises by two tendinous crura from the last dorsal vertebra, and in the Emeu by a double origin on each side. Nevertheless their diaphragm is incomplete; first, by reason of an arrest of its centripetal development, which leaves a permanent defect of union in the mesial plane; and secondly, by the large perforations for the abdominal air-cells.

The mechanism of respiration in the Apteryx is essentially the same as in other birds; and a more muscular diaphragm than it possesses would be unnecessary as a part of that mechanism. The abdominal surface of the diaphragm, as in the Mammalia, is principally in contact with the liver, spleen, and stomach; but its thoracic surface, as we have already seen, does not support the heart, and it is separated from the lungs by the interposition of a series of small but well-marked air-cells. There is no thoracic serous sac or pleura.

Thus, although the respiratory organs are confined to the chest, and the Apteryx offers
the only known instance in the feathered race of a species in which the receptacular part of the lungs is not continued into the **abdomen**; yet the Struthious type is strictly preserved, and the course of development has only been restricted, not changed.

The lungs, in fact, present all the peculiarities which characterize the class of Birds. They are fixed to the posterior part of the chest, and imbedded in the interspaces of the ribs, presenting a free anterior surface, slightly concave, extended on a plane nearly parallel with the axis of the trunk, and perforated by large apertures, through which the air passes from the bronchial tubes into the air-cells.

Each lung (Pl. V. figs. 4. & 5.) presents an irregular sub-compressed trihedral figure, broader anteriorly, and gradually contracted towards the posterior extremity, which is thin and rounded off: it is smooth and concave below; smooth and convex above, and outwardly; deeply indented along the upper or dorsal angle with six notches; the intermediate portions occupying the interspaces included between the second and the ninth ribs, and each sending off a small process. In the number of these posterior processes or lobes the *Apteryx* resembles the *Emeu*; in the *Cassowary* there are eight lobes; in the *Ostrich* and *Rhea* there are only five lobes in each lung.

The bronchial divisions of the **trachea** enter the lungs about one-fifth of their length from the anterior end, and almost immediately divide into four principal branches; one, a small branch (a, fig. 5.), is lost in the substance of the anterior part of the lung; a second, the largest branch (b, fig. 5.), runs down the concave surface, near to and parallel with the dorsal margin, and supplies the rest of the respiratory portion of the lung; the third branch, which is small, perforates the anterior part of the lung, and opens into the anterior air-cell; the fourth branch (c, fig. 5.) runs down the middle of the concave surface of the lung, and terminates by three successive orifices in the three inferior air-cells. The inner surface of this bronchial tube presents a great contrast with that of the second, which runs parallel with it, in the paucity of the **foramina** which it presents for the passage of air into the substance of the lung; these being extremely numerous in the second, as shown in the figure.

The pulmonary tissue is as compact, as vascular, and presents the same peculiar spongy texture as in other Birds. A stratum of fat was developed under the **pleura**, along the anterior margin of each lung. The first or most anterior of the air-cells interposed between the lung and the **diaphragm** is the smallest; the second the largest; this and the third present a cuboid figure: the **parietes** of these cells consist of an extension of the delicate mucous membrane of the air-passages, and an external thin layer of cellular tissue, by which they adhere to the **diaphragm**: the anterior air-cell on each side protrudes a little way through the anterior aperture of the thorax. (See Pl. V. fig. 4.)

The **larynx** and **trachea** resemble, in the simplicity of their structure, those of the other Struthious birds. The upper larynx is not defended by any rudimental **epiglottis**, nor provided with retroverted spines or **papillae**. The **glottis** (Pl. III. d, fig. 1.) is a long and moderately wide aperture: below the external or superior lips of the **glottis**,
and within the *larynx*, there are two thinner membranous folds: a small but elongated process projects from the middle line of the under or anterior part of the upper *larynx*, towards the *rima glottidis*. Behind the *glottis* there are two square-shaped tumid processes, with their free margins directed backwards into the *pharynx*; their texture is more glandular than the surrounding mucous membrane. The *trachea* corresponds in length with the neck, and preserves a nearly uniform diameter throughout its course; it consists of small and entire cartilaginous rings,—in one specimen, 120,—in another, 130 in number,—alternately overlapping and being overlapped at the sides when the tube is relaxed: they are also alternately narrower on one side and the other, but in a slight degree: they become gradually smaller to the last twenty rings, which are not connected so closely and rigidly together as in the Ostrich and Emeu. Remembering the cervical air-sac which projects through the ovate aperture discovered by Fremery\(^1\) in the anterior part of the *trachea* of the Emeu, and situated, as that accurate observer describes, between the fifty-third and sixty-second cartilaginous rings, I examined with care the *trachea* of the Apteryx, but without detecting any trace of an analogous structure in either sex.

There is no lower *larynx*. The last two tracheal rings increase in breadth, and the bronchial rings are continued from them with only a slight diminution of thickness: a membrane closes the *trachea* below, and completes the bronchial rings at their under part: near the termination of the *bronchiae* the cartilaginous hoops are incomplete above as well as below. Both circular and longitudinal muscular fibres enter into the structure of the short bronchial tubes.

The *sterno-tracheales* muscles (*Pl. V. a*, fig. 4; *Pl. III. g*, fig. 3.) arise, one from the inner surface of each coracoid bone.

It is plain, from the fixed condition of the lungs, and from the space between the lungs and *diaphragm* being occupied by air-cells, that inspiration could not be effectually performed by the action of the *diaphragm* alone: but the structure and mobility of the anterior *parietales* of the thorax indicate that it takes place in the Apteryx, as in other birds, by the *sternum* being depressed, and the angle between the vertebral and sternal ribs being increased.

All the triangular muscles which converge to be inserted into the costal processes thus become muscles of inspiration, and more especially those which represent the *serratus magnus anticus*, and which act from the true ribs as a fixed point below, upon the *scapula* above; for by drawing down that bone they bear upon the *sternum*, through the medium of the coracoid; and hence the necessity of strong and well-developed coracoid bones in a bird that otherwise could derive no particular advantage from the fixation of the *scapula*. The adherence to the ornithic type in the characteristic part of the osseous structure due to the *sternum, coracoids, and scapulae*, is thus not merely explicable.

\(^1\) De Casuario Nove Hollandiae. Svo. 1819.
on the theory of unity of plan, but relates in the _Apteryx_ to the exigences of respiration with fixed lungs and large air-cells.

**Renal and Genital Organs.**

The kidneys of the _Apteryx_ are situated symmetrically, and lodged, as in other birds, in the irregular hollows of the back part of the cavity of the _pelvis_; their posterior surface presents corresponding projections; the anterior surface is smooth and almost flat: the mesial edges of the kidneys are nearly straight and parallel, and very close to each other, but do not coalesce at any part; the outer edges are notched. Each kidney measures 3 inches in length, 11 lines across the broadest part, which is one-fourth from the anterior extremity, and 4 lines at the thickest part. It is divided into five lobes by oblique fissures, extending into the posterior surface of the gland: the middle lobe is the largest. These lobes appear to have a compact and even surface, but their cerebriform convolutions can be readily unravelled. The weight of both kidneys is 2 drs. 36 grs. avoirdupoise. The tortuous _ureter_ (w, PL IV.) emerges from the inner side of the posterior extremity of the kidney, and after a course of an inch and a half, terminates, as above described, in the upper and back part of the uro-genital cavity.

The _supra-renal_ bodies (x, x, PL IV.) were of an oval form, and yellow colour; of a homogeneous texture; each 3 lines in length, and adhering closely to the _vena cava_ (v).

The male organs of generation consist of two pretty equally developed _testes_ (y, y, PL IV.) situated on the sternal aspect of the atlantal extremities of the kidneys, and on each side of the _crura_ of the _diaphragm_. They were of a subcompressed oval figure, with a somewhat angular external margin, about 1 inch in length and 8 lines in breadth in the largest male _Apteryx_; but the dimensions of these glands are of course liable to vary according to the season or state of sexual excitement. Thus in the younger male _Apteryx_ they were subcompressed, subtriangular bodies, imbedded in the sternal and lateral aspects of the _supra-renal_ bodies, and not exceeding 5 lines in length. The _vasa deferentia_ (z, z, PL IV.) are formed by the union of numerous most minute efferent _tubules_, which pass from the _testes_, without forming an _epididymis_, into a soft amorphous substance, of a gray colour, which lies between the _testes_ and the bright yellow _supra-renal_ body. Some of the _efferent tubules_ are lost in the gray substance, which seems to be the remnant of the _corpus Wolffianum_; but the greater part perforate that body, and proceed to form the _vas deferens_. This tube is continued in the usual transversely undulated course, along the sternal aspect of the kidneys, and towards their mesial margins, to the urethro-sexual compartment, and terminate each on a prominent _papilla_ (h, h, PL IV.), situated in the uro-genital cavity, four lines below, and to the outer side of the urethral outlets, and three lines above the sides of the crescentic fold which separates the uro-genital from the vestibular compartment of the _cloaca_. The cresses or

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1 PL IV. v, v.
angles of the fold are continued into the margins of the penis, which projects from below the external orifice of the urethro-sexual cavity into the vestibular or outer compartment of the cloaca. The penis rapidly diminishes to a point, and its extremity is spirally retracted; when stretched out, the whole length of the intromittent organ is 1 inch and a half in length; but this, doubtless, falls short of the dimensions of the penis in the recent and erect condition. An urethral groove traverses the upper, or what, if the penis were drawn out of the cloaca and bent forwards along the abdomen, would be its under surface, by an urethral or rather seminal groove, which is continued to the end of its spiral extremity: the margins of this groove are not beset with papillae, but simply wrinkled transversely, as in the Emu and Ostrich. The two lateral cavernous crura of the penis are attached to the membranous parietes of the uro-genital cavity, and to a retractor or erector muscle which comes off from the inner surface of the lower edge of the ischium: one of these muscles is represented at Pl. III. n, fig. 3. The base of the penis is drawn towards the coccyx, and the veins quitting the corpora cavernosa are compressed by a second pair of muscles (o), narrower but thicker than the erectors, which arise from the fascia at the sides of the coccyx, pass downwards along the sides of the vestibule, and meet at a tendinous raphé on the dorsum penis. Immediately above the base of the penis, on each side, there is a considerable plexus (p) of both arteries and veins, with which also many filaments of nerves are intermingled. The last-described muscles cross over the base of this plexus in their course to the penis, and would doubtless impede, if not arrest, the current of blood in the veins; they might be termed, therefore, "compressores venarum penis," as they fulfil the same office as the compressores described by Douglas in the Dog. In this office of maintaining the erect and turgid state of the intromittent organ, the compressores are aided by two broad sphincters: the internal one (Pl. III. q, fig. 3.) rises from the sides of the coccyx, and more immediately surrounds the cloaca, meeting its fellow at the middle line of the inferior surface: the external sphincter (r) closes principally the external compartment of the cloaca.

The female organs in the specimen dissected presented their full functional development. The left ovarium was, however, too much decomposed to admit of any accurate observation of its structure being made: it consisted of an irregular and obscurely divided mass, of about three inches in length by two in thickness: the largest yolks appeared to have been about one inch in diameter. There was a perfectly distinct right ovarium situated in front of the corresponding supra-renal gland; it consisted of an irregularly oval flattened body, with a slightly granulate surface, nine lines long, six lines wide, and about one line in thickness. The part of the cloaca where a rudimental right oviduct, supposing one to have been present, might have terminated, was cut away.

The left oviduct was of large size, and from the condition of the lining membrane of the calcifying segment or uterus, seemed to have been exercising its function a brief period before death. The whole length of the oviduct was thirteen inches; it was disposed
in three principal convolutions, and its connexions were as usual in birds. It com-
mences with a thin slit-like mouth, with entire margins, two inches in width, but soon
contracts to a diameter of ten lines; it thence proceeds to expand very gradually to the
width of an inch, and is thus continued to the uterine or terminal segment: this portion
is two inches and a half in length, and one inch and a half in diameter: its inner sur-
face was studded with slightly arborescent calcifying follicles, arranged in transverse
rows. The lining membrane of the principal part of the oviduct was thrown into longi-
tudinal rugæ; the tube communicated with the cloaca by a short, contracted, and ob-
lique canal and orifice, with tumid margins. Both the upper and lower mesometries
presented the usual radiated muscular structure.

Osseous System.

The skeleton (Pl. VIII.) of the Apteryx exhibits, but in a less degree than the entire
bird, the Struthious disproportion between the anterior and posterior extremities, and
it shows that all the ordinary bones of the wing exist, though in their feeblest state of
development.

With the exception of the parts of the skeleton concerned in the formation of the
nasal and auditory cavities, none of the other bones of the Apteryx are perforated for
the admission of air, nor do they exhibit the pure white colour which characterizes the
skeleton in other birds. In their tough and compact texture they resemble the bones
of the Lizard tribe.

The skull (Pl. VII, figs. 1, 2, 5.) of the Apteryx is chiefly remarkable for its smooth,
expanded, elevated, pyriform cranial portion, the total absence of supra-orbital ridges,
the completeness and the thickness of the inter-orbital septum, the great development
of the ethmoid, the small size of the lacrymal bones, and the expansion of the nasal
cavity behind these bones. The combination of the depressed with the elongated and
slender form of the beak is of course as well marked in the skull as in the entire head
already described.

The occipital region of the cranium has a pretty regular semicircular contour, and dif-
fers from that of other Struthious birds in the greater relative extent of its base, and in
the comparatively slight lateral sinuosities due to the temporal depressions. The single
hemispherical tubercle in the basi-occipital, for the articulation with the atlas, has not
the vertical notch at the upper part observable in the Ostrich and Emeu, but is entire
as in the Rhea; and the plane of the occipital foramen has the same aspect as in that
bird, in which it is more nearly horizontal than in the Ostrich. The supra-occipital plate
forms a somewhat angular projection, corresponding with the small cerebellum within,
and is bounded on each side by a vertical vascular groove, terminated by a foramen above
and below: external to these grooves the ex-occipitals extend outwards and downwards,
in the form of obtuse processes, compressed in the antero-posterior direction, slightly
convex behind and concave in front, where they form the back part of the wide meatus auditorius externus. All the parts of the occipital bone were ankylosed together, and also to the surrounding bones.

The angle between the posterior and superior regions of the cranium is scarcely produced into a ridge. The superior region is smooth and regularly convex; it is separated from the temporal depressions by a narrow ridge, a little more marked than the occipital one. The sagittal suture runs across a little behind the middle of the upper part of the cranium: the left half of this suture, with the frontal suture, was persistent in one cranium of the Apteryx, which I extracted from a dried skin in Mr. Gould’s Museum; but all the sutures were obliterated in the skull of Mr. Bennett’s male specimen. The persistent sutures were more denticulated than those in the skull of a young Ostrich with which I have compared them.

The superior is continued into the lateral regions of the cranium by a continuous curvature, so that the upper part of the small orbital cavity is convex, and its limits undicinaliable, there being no trace of supraorbital ridge or antorbital or postorbital processes: this structure is quite peculiar to the Apteryx among birds, but produces a very interesting resemblance between it and the monotrematous Echidna. The temporal bone sends forwards a short and slender zygomatic process, which in its small relative development resembles most that of the Rhea among the larger Struthionidae.

The frontal bones gradually contract to their junction with the nasal bones, between which there is the trace of a small part of the ethmoid bone. The narrow frontal region of the skull is traversed by a mesial longitudinal depression.

The ethmoid bone is remarkably expanded in the Apteryx, and its cells, instead of being restricted to a narrow vertical septum of the orbits, as in the diurnal Struthionidae, occupy not only the ordinary orbital space, but extend outwards for more than two lines beyond the lateral boundaries of the anterior part of the frontals. A small process extends from the frontal to the side of the expanded ethmoid, anterior to the orbital foramina, which are distinct, and remarkably wide apart, and the expanded ethmoid is also supported anteriorly by a similar ankylosed conjunction with the lacrimal bone. The entire breadth of the ethmoid is 9 lines. The nearest approach to this peculiar structure of the Apteryx is made by the Ostrich, in which the interorbital septum, though much thinner than in the Apteryx, is also occupied by ethmoidal cells, and is thicker than in any of the other large Struthionidae. The Ibis (Numenius arceatus, Cuv., Pl. VII. figg. 3 & 4.) offers a striking contrast with the Apteryx in this respect, the interorbital osseous septum being almost entirely absent. In all the other parts of the cranium already noticed it also differs widely from the Apteryx. In the posterior region of the skull of the Ibis the bony covering of the cerebellum is in great part defective: in the superior part the cranial parietes above the cerebral hemispheres form two convexities, separated by a middle longitudinal depression, and the narrow space between the supraorbital ridges is occupied by the impressions corresponding to the nasal or
supraorbital glands: the whole cranium also is much higher and shorter in proportion to its breadth than in the Apteryx. The Ibis, in thus differing from the Apteryx, deviates also from the other Struthionidae.

At the base of the skull we find in the Apteryx all the peculiarities characteristic of the Struthious birds. The body of the sphenoid sends outwards on each side two processes, of which the posterior abuts against the tympanic bone, and the anterior one, by a flattened oval articular surface against the pterygoid bone: the latter processes exist, but are much more feebly developed, in the Ibis: in most other birds, including the Grallæ, they are wanting: they are well developed in the Lacertine Sauria. A compressed vomerine process is continued forwards from the anterior part of the basisphenoid, and this process is ankylosed to the under part of the expanded and cellular ethmoid.

In the interior of the cranium the olfactory depressions are seen to be proportionally larger than in other birds, and the olfactory nerve, instead of being continued along the upper part of an interorbital septum by a bony canal or groove to the nasal cavity, immediately passes, by many perforations, through a cribriform plate to the complex and extensive pituitary surface of the ethmoid bone.

The optic foramina are distinct both internally and externally, and are half an inch apart; they are perforated, not in the sphenoid ala, but in the inflected margin of the frontal bone. In these peculiarities the Apteryx differs from all the rest of its class: each optic foramen, however, transmits not only the optic nerve and ophthalmic artery, but also the third, fourth, first branch of the fifth and sixth nerves, as in most other birds. Of these nerves the fifth is the largest, and it is continued forwards to the nasal canal, through two foramina, one circumscribed externally by the process already mentioned, which extends from the frontal to the ethmoid; the other by the corresponding process of the lacrymal. The pituitary fossa, or sella turcica, is a very deep semi-oval depression; the common internal orifice of the two carotid canals communicates with its posterior part. On each side of the anterior part of the floor of the cranium, which supports the medulla oblongata, there is an oblique slightly curved groove, terminated at its anterior extremity by the foramen rotundum, at its posterior by the foramen ovale. These foramina are situated between the basilar and alar elements of the sphenoid; they are nearly of equal size, and are relatively larger than in the diurnal Struthionidae. The foramen rotundum is not only distinct, but is further apart from the foramen opticum than in any other bird. The petrous bone projects internally in the form of a thin semicircular plate of bone, commencing at the foramen ovale and extending backwards to the foramen auditorium internum, which it overhangs: this plate gives attachment to the tentorium. There is not any corresponding bony ridge developed from the upper wall of the cranium in the line of origin of the falx, as in many of the Gallinaceous birds. The anterior or cerebral division of the cranial cavity is larger in proportion to the posterior than in most other birds.
Of the bones more immediately concerned in the formation or motion of the jaws, that element of the temporal may be first described which in birds is always moveable and articulated at once with the cranium and both the upper and lower jaws.

The tympanic bone is of a subcompressed trihedral form, and sends forwards into the orbit a longer and slenderer process than in the larger Struthionidae: its upper articular surface is a transversely extended convex condyle, which plays in a corresponding cavity internal to the base of the zygomatic process. The opposite extremity is expanded, and presents two distinct articular convexities for the lower jaw, the inner one being the largest: above the external convexity there is a small but deep depression for the reception of the deflected extremity of the jugal bone.

The posterior extremity of the pterygoid bone is securely wedged in between the orbital process of the tympanic and the transverse process of the sphenoid: as it advances forwards it expands, as in the other Struthionidae, into a thin plate of bone, which is bent upon itself with its concavity turned inwards, and is continued by ankylosis into the palatine bones, so that the limits between them cannot be defined.

The palatine bones are in like manner confluent with the maxillaries. They are pierced by two narrow elliptical posterior nasal foramina, about 3 lines in length, over which the exterior margin of each palatine bone arches from without inwards, and these over-arching laminae gradually approximate, as they advance forwards, and meet about one inch anterior to the nasal foramina, from which an imperforate plate of bone, impressed with a narrow median fissure, and composed of the confluent palatal processes of the maxillary and intermaxillary bones, is continued to the end of the beak. The limits between maxillary and intermaxillary bones are indicated by two fine oblique lines, commencing at the outer margin of the roof of the mouth, about 2½ inches from the apex of the beak.

The jugal style, which in the Ostrich may be separated in the full-grown bird into a zygomatic and malar portion, consists in the Apteryx of a single slender compressed twisted bone, ankylosed with the maxillary bone in front, and terminated behind by an obtuse deflected extremity, which is received into a corresponding vertical cavity in the upper part of the outer process of the tympanic bone. By this mode of attachment the tympanic bone offers increased resistance to the pressure transferred to it by the lower jaw, at the same time that it gives additional strength to the upper mandible. It is continued backwards in the same line with the upper maxillary bone as in other Struthionidae, and is not bent downwards at its junction with the maxillary as in the Ibis and other Grallæ.

The superior maxillary bone presents the singular form of a nearly perfectly flat elongated triangular plate of bone, which is imperforate, and is continued by uninterrupted ossification with the intermaxillary. The Rheu among the Struthionidae makes the nearest approach to the Apteryx in the structure of this part of the skull; but the maxillary plate is perforated by large foramina, and sends upwards on each
side a process to join the lacrymal. In the Ibis the superior maxillary bones are in the form of slender round styles, having a wide interspace between them. In the Apteryx the small lacrymal bones are represented by two compressed plates of bone descending obliquely forwards from the anterior extremities of the frontals, and are articulated below to a small depression in the maxillary plate. They are each pierced by a single small foramen. The frontal, nasal, and intermaxillary bones form one continuous bony piece, too strong to admit of any elastic yielding movement between the upper jaw and cranium. The nasal and the upper or mesial portion of the intermaxillary bones form an elongated depressed narrow process, convex above, and with the outer margins bent inwards beneath the long nasal passages, of which they form the outer and part of the lower boundaries.

The lower jaw\(^\text{1}\) presents all the usual ornithic characters with the Struthious modifications traceable in the individual peculiarities. The transversely expanded angular and articular extremities offer the inwardly extended process for the attachment of the pterygoidei muscles: the superior transverse plate behind the articular surfaces is thin and concave towards the meatus auditorius externus, and is lined by the mucous membrane of that passage, of which it forms part of the bony parietes. There are two distinct narrow oblique articular surfaces, concave in the longitudinal and convex in the transverse directions; the internal one is the largest, and behind this there is a small excavation\(^\text{2}\) into which a small process of the air-sac lining the tympanum is continued; and this is the only part of the skeleton not immediately concerned in the formation of the organs of hearing or smelling into which air is admitted. The entry to the air-cells in the lower jaw of the Ostrich is situated in the part corresponding to the above depression or sinus in the jaw of the Apteryx. Traces of the compound structure of the lower jaw are very evident in that of the Apteryx, and the limits of the angular, articular and coronoid pieces may be in part defined. There is a linear vacancy, bounded by the surangular and angular pieces behind, and by the bifurcate commencement of the mandibular or dentary piece in front: the surangular is compressed, and sends upwards a very slightly elevated coronoid ridge. A second narrower fissure occurs between the thick opercular or splenial element and the upper fork of the mandibular piece. The opercular piece reaches to the posterior part of the symphysis as in the Ostrich, and the rest of the lower jaw in front of this part is formed by the two anchylosed mandibulars. In the extent of this anchyosed symphysis the Rhea makes the nearest approach to the Apteryx among the Struthionidae, and the two impressions which diverge from the back part to the front of the symphysis are present in both the Rhea and Emu as in the Apteryx. The lower jaw of the Apteryx differs from that of the Ibis in its greater posterior expanse, its more depressed form, the lower coronoid plate, the narrower fissure between the angular and surangular pieces, and the absence of the mesial furrow, extending in the Ibis to the end of the symphysis.

\(^1\) Pl. VII. Figg. 6. & 7.  
\(^2\) Pl. VII. Fig. 6. a.
The relations of the modifications of the skull of the Apteryx to its peculiar habits and kind of food are well marked and very easily traced; those which concern the maxillary portions have already been noticed in the account of the digestive system, and I need only add here that the anchylosed condition of all the parts concerned in the formation of the upper mandible is more complete than in the larger Struthionidae, and relates to the greater force with which the beak is used in obtaining the food. The nocturnal habits of the Apteryx, combined with the necessity for a highly developed organ of smell, which chiefly compensates for the low condition of the organ of vision, produces the most singular modifications which the skull presents, and we may say that those cavities which in other birds are devoted to the lodgement of the eyes, are here almost exclusively occupied by the nose.

The spinal column is relatively stronger, especially in the cervical region, than in the larger Struthionidae: it consists of fifteen cervical, nine dorsal, and twenty-two remaining vertebrae in the lumbar, sacral, and caudal regions.

The dorsal vertebrae are arranged in a straight line, and slightly increase in breadth to the seventh; the transverse processes of the eighth and ninth suddenly diminish. The third, fourth, fifth and sixth dorsal vertebrae are slightly anchylosed together by the contiguous edges of their spinous processes; the seventh, eighth and ninth are overlapped by the iliac bones; but notwithstanding this partial anchylosis, the synovial articulations, both between the bodies and oblique processes, are retained in all the dorsal vertebrae, and a slight, yielding, elastic movement is permitted between those vertebrae: the body of the last dorsal vertebra is anchylosed to the sacrum. The breadth of the bodies of the dorsal vertebrae diminishes, and their length increases very gradually from the first to the fourth; thence the bodies become broader and shorter in the same degree to the sacrum. A short obtuse process is sent off obliquely forwards from the inferior surface of the body of each of the first four dorsal vertebrae; the corresponding surface of the succeeding ones is smooth and slightly concave from side to side. The articulation between the bodies is by the adaptation of a surface slightly concave in the vertical and convex in the transverse direction at the posterior end of one vertebra to opposite curves at the anterior end of the succeeding one. Close to the anterior surface on each side there is a hemispherical pit for the reception of the round head of the rib: this articular pit is supported on a process representing the inferior transverse process, except in the three middle dorsal vertebrae. The transverse processes are broad, flat, and square-shaped, with the anterior angle obliquely cut off to receive the abutment of the tubercle of the rib, except in the second and third, in which a small process is sent down for the same purpose from the under surface of the transverse process: the transverse processes of the three last dorsal vertebrae abut against the under or inner surface of theilia, and are probably anchylosed thereto in old birds. The nerves issue from the interspaces of the vertebrae above the articulation of the heads of the ribs. The transverse processes are not connected together by extended long
splints, but are quite detached from each other, as in Struthious birds. The oblique processes offer no peculiarity; a process is continued backwards from the upper part of those belonging to the first and second dorsal vertebrae. The spinous process arises from the whole length of the arch of each vertebra; it is truncate above, and with the exception of the first, is of the same breadth throughout: all the dorsal spines are much compressed, the middle ones being the thinnest, slightly expanding at their truncate extremities, especially the three anterior ones, the first spine being notched behind to receive the contiguous angle of the succeeding one: below this there is a considerable interval between these two spines, but the rest of the spines are in contact throughout, and are probably more ankylosed in the older birds than was observed in the specimen here described. The length of the dorsal region of the spine is 4 inches.

The length of the vertebral column behind the dorsal vertebrae included between the osso innominata is 3 inches. The first four sacral vertebrae\(^1\) send outwards inferior transverse processes which abut against the ilia, and progressively increase in length and thickness. The breadth of these vertebrae also gradually increases; but it diminishes in the four succeeding vertebrae, in which the inferior transverse processes are wanting: then the ninth and tenth sacral vertebrae send outwards each a pair of strong inferior transverse processes to abut against the inner surface of the osso innominata immediately behind the acetabulum: the ankylosis of the bodies is continued through the four succeeding vertebrae, which are of a very simple structure, devoid of transverse or oblique processes, becoming gradually more compressed and more extended vertically, so as to appear like mere bony laminae; the line of the articulation between the bodies of these posterior sacral vertebra is obvious, but their spines coalesce to form a continuous bony ridge, which is closely embraced by the posterior extremities of the innominata. The foramina for the nerves are pierced in the sides of the bodies of the sacral vertebrae; they are double in the anterior ones, but single in the posterior compressed vertebrae, where they are seen close to the posterior margin.

There are nine caudal vertebrae, which are deeper, and project farther below the posterior portions of the iliac bones than in the other Struthious birds: these vertebrae, as they descend, progressively increase in lateral and diminish in vertical extent; the spinal canal is continued through the first five, and they are all moveable upon each other, excepting the two last, which combine to form a vertebra analogous to the expanded terminal vertebra in other birds, but which here exceeds the rest only in its greater length, and gradually diminishes to an obtuse point. In the Ostrich the corresponding vertebra is expanded for the support of the caudal plumes, but in the Apteryx it offers the same inconspicuous development as in the Rhea and Emeu.

The cervical vertebrae present all the usual ornithic peculiarities. Their general form and proportions are shown in the figure (Pl. VIII). The single inferior process for the attachment of the complicated longus colli anticus is present in the three last vertebrae.

\(^1\) See Pl. IX.
The inverted bony arch for the protection of the carotid arteries is first seen to be developed from the inner side of the inferior transverse processes of the twelfth cervical vertebra, but the two sides of the arch are not ankylosed together; the interspace progressively increases in the eleventh, tenth, and ninth vertebrae, and the groove widens and is lost at the fifth vertebra. The spinous process is thick and strong in the vertebra dentata, but progressively diminishes to the seventh cervical vertebra, where it is reduced to a mere tubercle; from the eleventh it progressively increases to the last cervical, in which it presents the strong quadrate figure which characterizes the same process in the dorsal vertebrae.

The large canal on each side for the vertebral artery and sympathetic nerve is formed by the ankylosis of a rudimental rib to the extremities of an upper and lower transverse process; the costal process diminishes in size in the anterior cervical vertebrae: it is wanting in the dentata, though an arterial canal of very small size is present on each side of that vertebra. In the atlas there are two small inferior transverse processes, but no canal. The superior or neurapophysial bony arch increases in extent as the cervical vertebrae approach the head, and in the third, fourth, and fifth vertebrae this part is perforated by a small foramen on each side. The spinal chord is least protected by the vertebrae in the middle of the neck, where there is the greatest extent of motion: there is a depression on the anterior and posterior parts of the spine in the second, third, fourth, and in the last six cervical vertebrae.

The length of the cervical region of the spine is 7 inches.

The close resemblance of the Bird to the Reptile in its skeleton is well exemplified in the young Ostrich, in which even when half-grown the costal appendages of the cervical region of the vertebral column continue separate and moveable, as in the Crocodile. I have already observed that they were ankylosed to the first fifteen vertebrae in the Aptyryx. The first dorsal rib is a slender style about an inch in length; the rest are remarkable for their breadth, which is relatively greater than in any other bird; the Cassowary in this respect approaches nearest to the Aptyryx. The second, third, fourth, and fifth ribs articulate with the sternum through the medium of slender sternal portions; that of the sixth also reaches the sternum, but is attached only to the sternal rib anterior to it, and a considerable interspace exists between its unattached extremity and that of its corresponding vertebral rib. In the first simple and floating rib, the part corresponding to the head and neck, as usual, is not developed, and it is attached to the transverse process by the part analogous to the tubercle. In the second rib a short and strong cervix, terminated by a hemispherical head, is given off below and in front of the tubercle, and works in a corresponding socket at the anterior margin of the vertebra. The head and tubercle, with the points of the vertebrae to which they are attached, intercept large foramina corresponding to the vertebral foramina in the cervical region. Immediately below the tubercle the rib suddenly expands, and then gradually narrows to its lower end: the neck of the rib increases in length in the third and fourth pairs and diminishes in the last two; the sixth rib begins to lose its breadth, and the rest become nar-
rower to the last. The bony appendages to the vertebral ribs are developed in the second to the eighth inclusive: they are articulated by a broad base to a fissure in the posterior margin of these vertebral ribs a little below their middle part; those belonging to the third, fourth, fifth, and sixth ribs are the longest, and overlap the succeeding rib: these processes are not ankylosed in the specimen described. The Rhea comes nearest to the Apteryx in the size of these costal appendages. The first four sternal ribs are transversely expanded at their sternal extremities, which severally present a concave surface lined with smooth cartilage and synovial membrane, and playing upon a corresponding smooth convexity in the costal margin of the sternum, which thus presents four true enarthrodial joints with capsular ligaments on each side. This elaborate structure is not, however, peculiar to the Apteryx among birds, but relates to the importance of the movements of the sternal ribs, which are the centres upon which the respiratory motions hinge,—the angles between the vertebral and sternal ribs, and between these and the sternum, becoming more open in inspiration when the sternum is depressed, and the contrary when the sternum is approximated to the dorsal region in expiration.

The sternum—the main characteristic of the skeleton of the bird—is reduced to its lowest grade of development in the Apteryx. In its small size, and in the total absence of a keel, it resembles that of the Struthious birds, but differs in the presence of two subcircular perforations on each side of the middle line, in the wide anterior emarginations, and in the much greater extent of the two posterior fissures.

The anterior margin presents no trace of a manubrial process as in the Ostrich: on the contrary, the wide interspace between the articular cavities of the coracoid is deeply concave: in the extent of this interspace the Rhea most resembles the Apteryx, but its contour is almost straight; in the Casowary the space is narrower but is deeply notched. The articular surface for the coracoid is an open groove, which in the fresh state is covered with articular cartilage: external to this groove the anterior angles of the sternum are produced into two strong triangular processes with the apex obtuse. The costal margin is thickened, and when viewed anteriorly, presents an undulating contour, from the presence of the four articular convexities for the sternal ribs and the intermediate excavations. The sternum of the Emeu presents a similar appearance. The breadth of each sternal perforation is nearly equal to that of the intervening osseous space; in the specimen described they were not quite symmetrical in position. The extent of the posterior notches is equal to one half the entire length of the sternum: the external boundaries of these notches curve towards each other: there is also a slight want of symmetry in the form, position, and extent of these notches, as may be seen in the figures (Pl. IX. Fig. 2 & 3.)

The scapula and coracoid are ankylosed: a small perforation anterior to the articular surface of the humerus indicates the separation between the coracoid and rudimental clavicle, of which there is otherwise not the least trace.

1 Pl. IX. fig. 4.
The coracoid is the strongest bone: its inferior expanded extremity presents an articular convexity, adapted to the sternal groove before described.

The scapula reaches to the third rib: it is a simple narrow plate of bone, slightly curved and expanded at both ends, but chiefly at the humeral articulation. Its length is one inch.

The humerus is a slender, cylindrical, styliform bone, slightly bent, 1 inch 5 lines in length; slightly expanded at the two extremities, most so at the proximal end, which supports a transverse oval articular convexity, covered with smooth cartilage, and joined by a synovial and capsular membrane to the scapulo-coracoid articulation. A small tuberosity projects beyond each end of the humeral articular surface. The distal end of the humerus is articulated by a true but shallow ginglymoid joint with the rudimental bones of the antibrachium, and both the external and internal condyles are slightly developed.

The radius and ulna are almost straight cylindrical slender bones, each 9 lines in length. A feebly developed olecranon projects above the articular surface of the ulna. There is a minute carpal bone, two metacarpals, and a single phalanx, which supports the long curved obtuse alar claw. The whole length of this rudimental hand is 7 lines, including the claw, which measures 3 lines and a half. A few strong and short quill-feathers are attached by ligament to the ulna and metacarpus.

The iliac bones in size and shape resemble those of the Struthious tribe: the length is 4 inches and 3 lines. The outer surface presents a slight concavity anteriorly, which gradually passes into a convexity posteriorly, the two surfaces not being separated by the transverse elevation observable above the acetabulum in the four large Struthious birds. A distinct epiphyseal piece of bone, of a compressed and triangular form, is wedged in between the posterior extremity of the ilia and the first three caudal vertebrae.

The ischium extends backwards, parallel with the sacrum, in the form of a thin plate of bone which slightly expands to its free extremity, which is truncated.

The pubic element is a slender bony style, connected by ligament to the end of the ischium, but attached by bone at its acetabular extremity only. A short pointed process extends from the anterior margin of the origin of the pubis. In comparing the pelvis of the Apteryx with that of the large Struthious birds, we find that the ischia do not meet below the sacrum as in the Rhea, but are more distant from that and the iliac bones than in any of the Struthious birds; the pubic bones are not joined together at their distal extremities as in the Ostrich; the extremities of the ischia are not anchylosed to the superincumbent ilia as in the Cassowary. It is the Emu which comes nearest to the Apteryx in the structure of the pelvis, but it also differs in the complete bony boundary of the foramen which transmits the tendon of the obturator internus, and which is completed posteriorly by ligament in the Apteryx.

The acetabulum communicates, as usual, by a wide opening with the pelvis: a surface
covered with a cushion of thick cartilage is continued from its posterior and upper part.

The fibrous capsule of the hip-joint is very strong; the synovial membrane is reflected from it upon the upper margin of the trochanter and upper part of the short neck of the femur; and also upon the ligamentous bridge continued from the upper and extended margin of the acetabulum, to its anterior part. The ligamentum teres is very large, but short; it consists of an infundibular process of synovial membrane, reflected from the circumference of the acetabular perforation to that of the depression on the head of the femur; and this synovial sheath incloses two distinct ligaments, which are twisted about each other like the crucial ligaments of the knee-joint. One of the ligamentous bands passes from the upper margin of the acetabular perforation to the lower edge of the femoral depression; the other comes off from the under part of the acetabular perforation, and winds round the back part of the preceding, to be inserted into the upper part of the femoral depression.

The femur has the usual characters of that bone in the class of birds. Its small round head is supported on a very short and thick neck, placed at right angles to the great and single trochanter: it presents at its superior part a large depression for the strong and complex ligamentum teres. The shaft of the femur is slightly bent, with the convexity forwards, which is increased by a thickening at the anterior part of the middle of the shaft. The condyles are separated by a wide and deep groove anteriorly, and by a triangular depression behind. The outer one is the largest, and is grooved externally, for the articulation of the head of the fibula: the inferior compressed border of the condyle is wedged in between the tibia and fibula. The length of the femur is 3 inches 9 lines. The tibia is five inches in length. Two angular and strong ridges are developed from the anterior part of the expanded head of the tibia; the external one affords attachment to fascia, and to the expanded tendon of the rectus femoris latissimus: the internal ridge has affixed to it the ligament of the small cartilaginous patella. The knee-joint is remarkably complicated. The internal lateral ligament is broad and thin; it gives origin to part of the soleus, and is attached to the internal semilunar cartilage. This fibro-cartilage divides at its anterior extremity into three ligaments: of these one is broad and thick, and goes to the posterior surface of the rotular cartilage; it represents the ligamentum mucosum; the other two ligaments are inserted at the interspace of the condyles. Beneath the internal semilunar cartilage a very strong ligament arises from the inner edge of the tibia, and is also attached to the interspace of the condyles. A strong external lateral ligament extends between the outer condyle and the head of the fibula: beneath or within this there is a second ligament, which passes from the outer condyle to the external semilunar cartilage. A thick ligament extends from the anterior parts of this cartilage to the back part of the ligamentum patellae. From the back part of the external semilunar cartilage a posterior crucial ligament extends to the condyloid interspace; lastly, a strong ligament arises from the fore part of the head of the tibia,
and passes upwards and backwards to be inserted, with the preceding ligament, into the back part of the interspace of the condyles. The head of the tibia sends down an angular ridge posteriorly: the shaft of the bone is rounded, slightly compressed, converging to a ridge externally, to which ridge the fibula is attached in two places, beginning half an inch below the head of the fibula, and continuing attached for 10 lines; then again becoming ankylosed, after an interspace of 9 lines. In one specimen I found the fibula also ankylosed to the tibia by its expanded and thick proximal extremity: it quickly diminishes in size as it descends, and gradually disappears towards the lower fourth of the tibia. The distal end of the tibia presents the usual trochlea form, but the anterior concavity above the articular surface is in great part occupied by an irregular bony prominence.

There is a small cuneiform tarsal bone wedged into the outer and back part of the ankle-joint. The ankylosed tarso-metatarsal is a strong bone, 2 inches 3 lines in length; the upper articular surface is formed by a single broad piece. The original separation of the metatarsal bone below into three pieces is plainly indicated by two deep grooves on the anterior and posterior part of the proximal extremity: the intermediate portion of bone is very narrow anteriorly, but broad and prominent on the opposite side. The bone becomes flattened from before backwards, and expanded laterally as it descends, and divides at its distal extremity into three parts, with the articular pulleys for the three principal toes.

The surface for the articulation of the fourth, or small internal toe, is about half an inch above the distal end, on the internal and posterior aspect of the bone. A small ossicle, attached by strong ligaments to this surface, gives support to a short phalanx, which articulates with the longer ungueal phalanx.

The number of phalanges in the other toes follows the ordinary law, the adjoining toe having three, the next four, and the outermost five phalanges. The relative size and the forms of these bones are shown in the figures of the skeleton (Pl. VIII).

**Organs of Sense.**

The requisite particulars regarding the nervous system of the Apteryx will be subsequently described. The cavity of the cranium indicates the brain to have been proportionally larger than in the diurnal Struthionidae.

Of the organs of special sense, the ear, as we have already seen, resembles that of the larger Struthionidae in the development of the external passage: the structure of the internal organ was conformable to the typical condition of this part in Birds.

The eye, on the contrary, presented a remarkable deviation from the construction which characterizes the feathered class, in the total absence of the pecten or marsupium. We may conceive that this modification relates to the nocturnal habits and restricted locomotion of the present singular species. The eye-ball is relatively much smaller
than in other birds; its antero-posterior diameter is three lines; its transverse diameter four lines. The cornea transparens is very convex, and two lines in diameter. The sclerotic is thin, but the margin supporting the cornea is strengthened by a circle of small osseous plates. The choroid is a delicate membrane; its pigment is of a light brown colour. The ciliary processes commence at the ciliary ring, each process having at its origin a slight linear rising, which becomes gradually wavy and tortuous as it approaches the lens, anterior to the circumference of which it projects freely to a small extent. The iris in the specimen examined was one-third of a line in breadth. The optic nerve terminates by a small round aperture. The lens is two lines in breadth, and nearly one line at the thickest part, being thus more convex than in other birds. The external appendages of the eye presented no peculiarities, except the very great strength of the orbicularis palpebrarum; the membrana nictitans had the usual trochlear muscles: its free margin was black.

The singularly long and narrow nasal passages are closed and defended externally by the inflected outer margins of the nasal and upper process of the long intermaxillary bones. The relative extent and complexity of the turbinated bones, and the capacity of the posterior part of the nasal cavity exceed those of any other bird; and the sense of smell must be proportionally acute and important in the economy of the Apteryx.

Affinities of the Apteryx deducible from its Anatomy.

On a review of the preceding details of the organization of the Apteryx, it will be seen that, commencing with the skeleton, all the leading modifications of that basis of its structure connect it closely with the Struthious group. In the diminutive and keel-less sternum it agrees with all the known Struthious species, and with these alone. The two posterior emarginations which we observe in the sternum of the Ostrich are present in a still greater degree in the Apteryx; but the feeble development of the anterior extremities, to the muscles of which the sternum is mainly subservient as a basis of attachment, is the condition of a peculiarly incomplete state of the ossification of that bone of the Apteryx; and the two subcircular perforations which intervene between the origins of the pectoral muscle on the one side, and those of a large inferior dermo-cervical muscle on the other, form one of several unique structures in the anatomy of this bird. We have again the Struthious characters repeated in the atrophy of the bones of the wing, and the absence of the clavicles, as in the Rhea¹. Like testimony is borne by the expansively developed iliac and sacral bones, by the broad ischium and slender pubis, and by the long and narrow form of the pelvis. We begin to observe a

¹ In the Ostrich the clavicles are undoubtedly present though ankylosed with the scapula and coracoids, and separate from each other. In the Cassowary and Emu they exist as separate short styliform bones.
deviation from the Struthious type in the length of the femur, and a tendency to the gallinaceous type in the shortness of the metatarsal segment: the development of the fourth or inner toe may be regarded as another deviation; but it should be remembered that in the size and position of the latter the *Apteryx* closely corresponds with the extinct Struthious Dodo. The claw on the inner toe of the *Apteryx* has been erroneously compared with the spur of certain Gallinae, but it scarcely differs in form from the claws of the anterior toes.

In the broad ribs (see the Cassowary), in the general freedom of anchylosis in the dorsal region of the vertebral column, and the numerous vertebrae of the neck, we again meet with Struthious characters; and should it be objected to the latter particular, that some Palmipeds surpass the Ostrich in the number of cervical vertebrae, yet these stand out rather as exceptions in their particular order; while an excess over the average number of cervical vertebrae in birds is constant in the Struthious or Brevipennate group. Thus in the Cassowary 19 vertebrae precede that which supports a rib connected with the sternum, and of these 19 we may fairly reckon 16 as analogous to the cervical vertebrae in other birds. In the Rhea there are also 16 cervical vertebrae, and not 14, as Cuvier states. In the Ostrich there are 18, in the Emu 19 cervical vertebrae. In the *Apteryx* we should reckon 16 cervical vertebrae if we included that which supports the short rudimental but moveable pair of ribs. Of the 22 true grallatorial birds cited in Cuvier’s Table of the number of Vertebrae, only 9 have more than 14 cervical vertebrae; while the *Apteryx* with 15 cervical vertebrae, considered as a Struthious bird, has the fewest of its order. Its neck is relatively shorter, in correspondence with the shorter legs; the Cassowary, among the Struthionidae, comes nearest to the *Apteryx* in these proportions.

The free bony appendages of the ribs, and the universal absence of air-cells in the skeleton, are conditions in which the *Apteryx* resembles the *Aptenodytes*, but here all resemblance ceases: the position in which the *Apteryx* was originally figured¹ is incompatible with its organization.

The modifications of the skull of the *Apteryx*, in conformity with the structure of the beak requisite for obtaining its appropriate food, are undoubtedly extreme; yet we perceive in the cere which covers the base of the bill in the entire *Apteryx* a structure which exists in all the Struthious birds; and the anterior position of the nostrils in the subattenuated beak of the Cassowary is an evident approach to that very singular one which peculiarly characterizes the *Apteryx*. With regard to the digestive organs, it is interesting to remark, that, with the exception of the Ostrich, the thickened muscular parietes of the stomach of the granivorous Struthious birds do not exhibit that apparatus of distinct musculi digastrici and laterales which forms the characteristic structure of the gizzard of the gallinaceous order: thus the *Apteryx*, in the form and structure of its stomach, adheres to the Struthious type. It differs again in a marked degree from the

¹ Shaw’s Miscellany, xxiv. pl. 1075.
Gallinæ in the absence of a crop. With respect to the caecal appendages of the intestine, though generally long in the Gallinæ, they are subject to great variety in both the Struthious and Grallatorial orders: their extreme length and complicated structure in the Ostrich and Rhea form a peculiarity only met with in these birds. In the Cassowary, on the other hand, the caeca are described by the French academicians as entirely absent. Cuvier speaks of “un caecum unique” in the Emeu. In my dissections of these Struthious birds I have always found the two normal caeca present, but small; in the Emeu measuring from three to five inches long, and half an inch in diameter; in the Cassowary measuring about four inches in length. The presence of two moderately developed caeca in the Apteryx affords therefore no indication of its recession from the Struthious type: these caeca correspond in their condition, as they do in the other Struthious birds, with the nature of the nutriment of the species. It is dependent on this circumstance also, that in the grallatorial bird (Ibis), which the Apteryx most resembles in the structure of its beak, and consequently in the nature of its food, the caeca have nearly the same relative size; but as regards the Grallæ, taken as an order, no one condition of the caeca can be predicated as characteristic of them. In most they are very small; in many single.

What evidence, it may next be asked, does the generative system afford of the affinities of the Apteryx? A single, well-developed, inferiorly grooved, subspiral intromittent organ attests unequivocally its relations to the Struthious group; and this structure, with the modifications of the plumage of the respiratory organs and of the skeleton, lead to the same conclusion as that at which Mr. Yarrell and myself had arrived, from a study of the external organization of the Apteryx, viz. that it must rank as a genus of the cursorial or Struthious order. In deviating from the type of this order the Apteryx manifests a tendency in the structure of the feet to the Gallinæ, and in the form of the beak to the Grallæ; but it cannot, without violation of its natural affinities, be classed with either.

1 Leçons d'Anat. Comp. 1836. iv. p. 291.
2 The accurate Fremery speaks of “caeca intestina duos pollices tantum longa, dimidium lata,” in the Emeu dissected by him, loc. cit. p. 76.
3 Loc. cit., p. 72.
MUSCULAR SYSTEM.

The former part of this memoir on the Anatomy of the *Apteryx australis* includes the description of the osteology and splanchnology, with the male organs of generation; the present part is devoted to the illustration of the myology of the same rare and anomalous bird. The specimens which I have dissected for that purpose were afforded me by the Earl of Derby, President, and by Mr. George Bennett, F.L.S., of Sydney, Corresponding Member of the Zoological Society, to whom I am much indebted for such valuable opportunities of completing this monograph on the Apteryx.

The muscular system offers a subject of peculiar interest to the Comparative Anatomist when studied in a species which, in its general proportions and habits of life, deviates in so extreme a degree from the rest of the circumscribed and well-marked class to which it belongs. It is also a department of the anatomy of birds which, from the minute attention and length of time required for its accurate investigation, has been commonly passed over in anatomical monographs of species, but which the rarity of the *Apteryx* and the excellent state of preservation of the specimens dissected have both stimulated and enabled me to pursue with a degree of care which will be found, I trust, if tested by subsequent dissection, to have left little to be added to the myology of the species.

In the application of the facts detailed to the higher generalizations of the philosophy of organized bodies, it will be found that the unity of the ornithic type is strictly preserved, though under the extremest modifications; the characteristic peculiarities, for example, of the muscles of the spine and those of the wing, are all present, but the proportionate development of these classes of muscles is reversed, the spinal muscles being at their maximum, the alar muscles at their minimum of development. Very interesting peculiarities are likewise manifested by the muscles of the skin, with which I propose to introduce the details of the muscular system of the small Struthious bird of New Zealand.

Muscles of the Skin.

No detailed description of the muscles of the skin in Birds has been given either in the systematic works on Comparative Anatomy, or in particular treatises; these muscles appear indeed in general to be too irregularly or too feebly developed to have attracted

much attention: brief notices are recorded of some peculiarly developed cutaneous, or rather cuticular, muscles, as those which spread the plumes of the Peacock, erect the hackles of the Cock, and make each individual feather stand on end in the web-footed birds*; the compressors of the subcutaneous air-cells are noticed in the anatomical account of the Gannett (Sula Bassana†); and a more constant cutaneous muscle, viz. that which supports the crop in Gallinaceous birds, is briefly mentioned and figured by Hunter‡.

In the Apteryx, however, the true cutaneous system of muscles presents a more distinct and extensive development than has hitherto been met with in the class of Birds—a condition which is evidently connected with the peculiar thickness of the integument, and probably with the burrowing habits of this species, which thereby possesses the power of shaking off the loose earth from its plumage, while busy in the act of excavating its chamber of retreat and nidification.

**Constrictor colli** (Pl. X, XIII. a).—The whole of the neck is surrounded by a thin stratum of muscular fibres, directed for the most part transversely, and extending from an attachment along the median line of the skin at the back of the neck, to a parallel raphe on the median line of the opposite side: this muscle is strongest at its commencement or anterior part, where the fibres take their origin in a broad fasciculus from the outer part of the occipital ridge; these run obliquely downwards and forwards on each side of the neck, but are continued uninterruptedly with those arising from the dorsal line of the skin above mentioned; the direction of the fibres insensibly changing from the oblique to the transverse. The outer surface of this muscle is attached to the integument by a thin and dense layer of cellular tissue, devoid of fat; the under surface is more loosely connected with the subjacent parts by a more abundant and finer cellular tissue.

**Use.**—To brace the cervical integument, raise the neck feathers, and in combination with the following muscle to shake these parts.

**Sterno-cervicalis** (Pl. X, b).—**Origin.** Fleshy, from the posterior incurved angular process of the sternum, from the ensiform prolongation and middle line of the outer and posterior surface of the same bone. **Insertion.** The fibres pass forward, and, diverging in gently curved lines, ascend upon the sides of the broad base of the neck, and are inserted by a thin but strong fascia into the median line of the dorsal integument. This muscle is a line in thickness at its origin, but becomes thinner as it expands; the anterior part is covered by the posterior fibres of the **constrictor colli**.

**Use.**—To retract the skin of the neck, and brace that portion which covers the base of the neck; when these are the fixed points, it will depress and protract the sternum, and thus aid in inspiration.

**Obs.**—In its position and the general course of the fibres, this muscle is analogous to

* Nitzsch, art. Dermorhynchi, Ersch und Grüber's Encyclopedie.
† Proceedings of the Zoological Society, 1832, p. 91.
‡ In description of pl. 10, vol. i. of Physiological Catalogue of Hunterian Collection, 4to. 1833–1841.
that which supports and assists in emptying the crop in the common Fowl; but the œsophagus presents no partial dilatation in the Apteryx, and the situation of the crop is occupied by a large mass of fat enclosing one or two absorbent glands (Pl. XIII. d').

Sterno-maxillaris (Pl. XIII. c).—This muscle appears at first view to be the anterior continuation of the preceding, but is sufficiently distinct to merit a separate description and name. Origin. Fleshy; from the anterior part of the middle line of the sternum. Insertion. It passes directly forwards along the under or anterior part of the neck, expanding as it proceeds, and gradually separating into two thin symmetrical fasciculi, which are insensibly lost in the integument covering the throat and the angle of the jaw. It adheres pretty closely to the central surface of the constrictor colli, along which it passes to its insertion.

Use.—To retract the fore-part of the skin of the neck, and also the head. Each lateral portion acting alone would incline the head to its own side: the whole muscle in action would bend the neck; but the movements of the head and neck are more adequately and immediately provided for by the appropriate deeper-seated muscles, and the immediate office of the present muscle is obviously connected with the skin. Nevertheless, in so far as this muscle acts upon the head, it produces the same movements as the sterno-mastoideus in Mammalia; and it is interesting to observe, that in the long-necked Ruminants (as the Giraffe) the sterno-mastoid muscles arise by a common origin, and the insertion is by an extended fascia into the angles of the jaw: I consider, therefore, that the sterno-mastoides is represented by the sterno-maxillaris in the Apteryx.

Dermo-transversalis (Pl. XIII. d).—The skin covering the dorsal aspect of the lower two-thirds of the neck, besides being acted upon by the constrictor colli, is braced down by a thin stratum of oblique and somewhat scattered fibres, which take their origins by fasciae attached to the inferior transverse processes of the sixth to the twelfth cervical vertebrae inclusive; the fibres pass obliquely upwards and backwards, and are inserted by a thin fascia into the median line of the skin, covering the back of the neck.

Platysma myoides (Pl. X. e).—The representative of this cutaneous muscle is a thin triangular layer of muscular fibres, taking their origin from the outer side of the ramus of the jaw, and diverging as they descend to spread over the throat, and meeting their fellows at a middle raphe of insertion beneath the upper larynx and beginning of the trachea, which they thus serve to compress and support.

Dermo-spinalis (Pl. X. f).—Origin. By a thin fascia from the ends of the spinous processes of the three anterior dorsal vertebrae. Ins. The fibres slightly converge to be attached to the integument covering the scapular region.

Dermo-iliacus (Pl. X. g).—Origin. Fleshy, from the anterior margin of the ilium. Ins. The fibres pass forwards and slightly converge to be inserted into the scapular integument.

Dermo-costalis (Pl. X. h).—A muscle resembling the preceding in form. Origin. Fleshy, from the costal appendages of the seventh and eighth ribs. Ins. The fibres
pass forwards and join those of the preceding muscle, to be inserted into the scapular integument.

Obs. The three preceding muscles are broad and thin, but well-defined; they would appear to influence the movements of the rudimentary spur-armed wing through the medium of the integument, as powerfully as do the rudimental representatives of the true muscles of that extremity.

There are also two muscles belonging to the cutaneous series, and inserted directly into the bones of the wing. One of these, the Dermo-ulnaris (Pl. X. i) is a small, slender, elongated muscle, which takes its origin from the fascia beneath the dermo-costalis; its fibres pass backwards, and converge to terminate in a very slender tendon which expands into a fascia, covering the back part of the elbow-joint.

Use.—To extend the elbow-joint and raise the wing.

The Dermo-humeralis (Pl. X. k) is also a long and narrow strip, deriving its origin from scattered tendinous threads in the subcutaneous cellular tissue of the abdomen: it passes upwards, outwards and forwards, and is inserted fleshy into the proximal part of the humerus, which it serves to depress*.

Muscles of the Trunk.

A. On the Dorsal Aspect.

The muscles on the dorsal aspect of the vertebral column in Birds have only of late years received any attention from Comparative Anatomists: they have been mentioned rather than described by Tiedemann and Meckel: Carus has given a side-view of the superficial layer of muscles in the Sparrow-hawk; their best description is contained in the second edition of the 'Leçons d'Anatomie Comparée' of Cuvier.

The muscles of the back are in general so feebly developed in birds of flight, that they were affirmed by Cuvier to be wanting altogether in the first edition of the 'Leçons:' and this is almost true as respects their carneous portion, for they are chiefly tendinous in birds of flight. In the Struthious birds, and in the Penguin, in which the dorsal vertebrae are unfettered in their movements by ankylosis, these muscles are more fleshy and conspicuous; but they attain their greatest relative size and distinctness in the Apteryx.

From the very small size of the muscles which pass from the spine to the scapula and

* In Mammalia the cutaneous muscles form a more continuous stratum than in the Apteryx and other birds, and hence have been grouped together under the common term panniculus carnosus; they have also, in general, both their origins and insertions in the integument; but in Birds, in which the integument supports so extraordinary an abundance of the epidermic material under the form of feathers, the muscles destined to its especial motions require a more fixed attachment from which to act. The Rhinoceros, in which the integuments, from the thickness and density of the corium, are in a similar condition as regards the resistance to be overcome by the skin-muscles, presents an analogous condition of its panniculus carnosus, having it divided into several distinct muscles, most of which take their origin from bone or fascia attached to bone.
humerus in the *Apteryx*, the true muscles of the back, which correspond to the second layer of the dorsal muscles in Man, become immediately visible on removing the dorsal integuments and fasciae; they consist of the *sacro-lumbalis*, *longissimus dorsi*, and *spinalis dorsi*. The first two muscles are blended together at their posterior origins, but soon assume the disposition characteristic of each as they advance forwards.

The *sacro-lumbalis* ([Pl. XI. XII. l]) is a strong and fleshy muscle, six lines in breadth, and three or four lines in thickness: it is, as usual, the most external or lateral of the muscles of the back, and extends from the anterior border of the ilium to the penultimate cervical vertebra. *Origin.* By short tendinous and carneous fibres from the outer half of the anterior margin of the ilium, and by a succession of long, strong, and flattened tendons ([Pl. XII. l 1–l 5]) from the angles of the fifth and fourth ribs, and from the extremities of the transverse processes of the third, second, and first dorsal vertebrae; also by a shorter tendon (l 6) from the transverse process of the last cervical vertebra; these latter origins represent the *musculi accessorii ad sacro-lumbalem*; to bring them into view, the external margin of the *sacro-lumbalis* must be raised, as in [Pl. XII. fig. 2. These accessory tendons run obliquely forward, expanding as they proceed, and are lost in the under surface of the muscle.

*Insertion.* By a fleshy fasciculus with very short tendinous fibres into the angle of the sixth rib, and by a series of corresponding fasciculi, which become progressively longer and more tendinous, into the angles of the fifth, fourth, third and second ribs ([Pl. XI. l*]), and into the lower transverse processes of the first dorsal and last two cervical vertebrae: the last insertion is fleshy and strong; the four anterior of these insertions are concealed by the upper and outer fleshy portions of the *sacro-lumbalis*, which divides into five elongated fleshy bundles ([Pl. XI. l**]), inserted successively into the upper transverse processes of the first three dorsal and last two cervical vertebrae. These last insertions seem to represent the continuation of the *sacro-lumbalis* in Man, which is termed the *cervicalis descendens* or *ascendens*.

*Longissimus dorsi* ([Pl. XI. XII. m]).—This muscle is blended posteriorly both with the *sacro-lumbalis* and the *multifidus spinae*, and anteriorly with the outer portion of the *spinalis dorsi*. It extends as far forward as the thirteenth cervical vertebra. *Origin.* From the inner or mesial half of the anterior margin of the ilium; from a strong aponeurosis attached to the spines of the eighth, seventh and sixth dorsal vertebrae; and from the transverse processes of the sixth, fifth, fourth and third dorsal vertebrae. *Ins.* The carneous fibres continued from the second origin, or series of origins from the spinous processes, incline slightly outward as they pass forward, and are inserted into the posterior articular processes of the first three dorsal vertebrae, receiving accessory fibres from the *spinalis dorsi*. The fasciculi from the transverse processes incline inwards, and are also inserted into the posterior oblique processes of the vertebrae anterior to them; they receive fibres from the iliac origin, and soon begin to form a series of oblique carneous fasciculi, which become more distinct as they are situated more anteriorly; they are at
first implanted in the vertebra next in front of that from which they rise, and then into the vertebra next but one in front \((m^\ast)\): the most anterior of these tendons of insertions, to which can be traced any of the fibres of the main body of the *longissimus dorsi* (reflected back in Pl. XII. fig. 1, \(m\)) is that which is implanted into the thirteenth cervical vertebra \((m^{\ast\ast})\); it is this fasciculus which is joined by the first or most posterior of the *fasciculi obliqui* of the *longus colli posticus* \((o\ 1)\) which is detached and reflected upwards in fig. 1. Pl. XII.

**Obliquus colli** (Pl. XI. XII. \(m\ 1—9)\).—A series of oblique carneous fasciculi, evidently a continuation of, or part of the same system with those in which the *longissimus dorsi* terminates anteriorly, is continued between the upper transverse process of one cervical vertebra to the posterior oblique processes of the next vertebra but one in advance, as far forward as the fourth cervical vertebra. This series of muscles seems to represent the _transversalis colli_†, which is the anterior continuation of the *longissimus dorsi* in Mammalia, but it differs in being inserted into the oblique, instead of the transverse processes. In the direction of their fibres these fasciculi resemble the *semispinalis colli*, but they are inserted into the oblique processes instead of the spines of the vertebrae. There are no other muscles with which they can be compared in the Mammalia than these two, with neither of which, however, do they precisely correspond; they seem clearly to represent the second series of oblique muscular fasciculi in the trunk of Fishes, but to avoid the expression of an incomplete or false analogy, I shall term them collectively the _fasciculi obliqui_.

The *fasciculi obliqui* which rise from the first two dorsal and five lower cervical vertebrae are joined near their tendinous terminations by corresponding oblique fasciculi \((o\ 1—8)\) of the *longus colli posticus*, and the strong round tendons continued from the points of convergence of these fascicles are inserted successively into the posterior oblique processes of the twelfth to the sixth cervical vertebra inclusive; the two fasciculi next in succession receive no accessory fibres from the *longus colli posticus*; the anterior one \((m\ 9)\) derives an extensive origin from the upper transverse processes of the eighth, seventh, and sixth cervical vertebrae. It must be observed, however, that the whole of each fasciculus is not expended in the strong round tendinous insertion above described; the portion \((m^\ast,\ \text{fig. 1. Pl. XII.})\), which arises from the anterior ridge of the transverse process, passes more directly inwards than the rest, and is attached to the tendon which terminates the fasciculus immediately behind; at the middle of the neck these accessory fibres approach to the character of distinct origins. The tendons of insertion, moreover, severally receive accessory fleshy fibres \((n\ n,\ \text{fig. 1. Pl. XII.)}\) from the base of the oblique

† It is the ‘grand transversaire’ of Cuvier, loc. cit. p. 282; but he describes it as passing from the anterior articular process of one vertebra to the posterior articular process of the next in front. Meckel, who calls this muscle ‘intertransversalis cervicis,’ follows Cuvier in the description of its attachments, and adds, that it is a continuation of the outer division of the ‘extensor communis dorsi’ (sacro-lumbalis). In the Apteryx it is plainly a continuation of the inner division or *longissimus dorsi*. See Vergleich, Anatomie, Th. 3. p. 294.
processes of the two vertebrae next behind; and thus they become the medium of muscular forces acting from not less than five distinct points, the power of which is augmented by each tendon being braced down by the oblique converging series of muscles immediately anterior to it. The fasciculus from the eighth cervical vertebra, besides its insertion by the ordinary tendon, sends off externally a small pyramidal bundle of muscular fibres (Pl. XI, n*), which soon terminates in a long and slender tendon which is inserted into the oblique process of the third cervical vertebra. Corresponding portions of muscle (Pl. XI, & XII, n**) are detached from the two anterior fasciculi, which converge and terminate in a common slender tendon inserted into the posterior oblique process of the fourth cervical vertebra; and thus terminates this complex muscle or series of muscles.

Longus colli posticus (Pl. XI, & XII, fig. 1. o 1—9).—The most internal or mesial of the superficial muscles of the dorsal aspect of the thoracic and cervical regions, called *cervicalis ascendens* by Meckel, and compared in part with the *spinalis dorsi* by Cuvier, cannot be the representative of either of these muscles, since they both (l** & p) co-exist separately with it in the *Apteryx*. At its posterior part the muscle in question seems to be rather a continuation of the *longissimus dorsi*; its mesial and anterior part offers a strong analogy with the *biventer cervicis*; it appears to me to be evidently the analogue of the first, or mesio-dorsal series of oblique fibres of the muscular system in Fishes, but I shall adopt the name of the *longus colli posticus* applied to it by Cuvier†. It commences by long and slender, but strong, subcompressed tendons from the spines of the sixth, fifth and fourth dorsal vertebrae (Pl. XII, o): these tendons gradually expand as they proceed forwards and downwards, and send off from their under surface muscular fibres which continue in the same course, and begin to be grouped into distinct fasciculi at the base of the neck: the first of these bundles (o 1) joins the fasciculus of the *longissimus dorsi* (m**), which is inserted into the posterior articular process of the thirteenth cervical vertebra; the succeeding fasciculi derive their origins from a broad and strong aponeurotic sheet attached to the spines of the fourth, third and second dorsal vertebrae: the second to the eighth fasciculi inclusive are compressed, broad and fleshy, and are inserted in the strong round tendons described in the preceding muscle, and attached to the oblique processes of the twelfth to the sixth cervical vertebrae inclusive: the ninth fasciculus (o 9), which forms the main anterior continuation of the *longus colli posticus*‡, is larger than the rest, and receives, as it advances, accessory fibres from the spinous processes of the seventh (o*) to the third cervical vertebrae inclusive, and is inserted, partly fleshy, partly by a strong tendon, into the side of the broad spine of the *vertebra dentata*. A slender fasciculus is detached from the mesial and dorsal margin of the *longus colli posticus*, near the base of the neck, which soon terminates in a long round tendon (o**) this tendon is braced down by short aponeurotic fibres to the spine of the fifth, fourth, third and

† Leçons d'Anat. Comp., 2nd edit. vol. i. p. 284.
‡ 'Accessoires du long postérieur du cou,' Cuvier, loc. cit. p. 284.
second cervical vertebrae inclusive, immediately beyond which it again becomes fleshy, and expands to be inserted into the occipital ridge: this portion is the digastrique or biventer capitis of Cuvier.

Spinalis dorsi (Pl. XII, fig. 1. p).—The displacement of the dorsal portion of the preceding muscle and the longissimus dorsi brings into view the spinalis dorsi, which is a well-developed and distinct muscle in the Apteryx. Origin. By two long, narrow, flattened tendons (p, 1 & 2.) from the spines of the eighth and seventh dorsal vertebrae: these pass obliquely downwards and forwards, expanding as they proceed, and terminate in two fasciculi of muscular fibres: the posterior bundle passes forwards beneath the anterior one, and inclining inwards and upwards, divides into two portions, inserted by long tendons into the spines of the second and first dorsal vertebrae (p 1*); it then sends a few fibres forwards to join the outer and anterior fasciculus, which is partly inserted by a slender tendon into the spine of the last cervical vertebra: the rest of the fibres of the second fasciculus join the portion of the longissimus dorsi (m) which is implanted into the posterior oblique process of the last cervical vertebra. The three inserted tendons of the spinalis dorsi are also the medium of attachment of fibres continued from the multifidus spinæ, beneath them.

Multifidus spinæ (Pl. XII, fig. 1. q).—The series of muscles so called arises by fleshy fibres from the transverse processes of the five last dorsal vertebrae, which pass upwards, forwards and inwards, to be inserted by four flat tendons into the spines of the seventh to the third dorsal vertebrae inclusive, and by the tendons of the spinalis dorsi into the two anterior dorsal spines.

Obliquo-spinales (Pl. XII, fig. 3. r).—The removal of the multifidus spinæ brings into view a series of long, narrow, flat tendons, coming off from the spines of all the dorsal vertebrae, and slightly expanding as they proceed forwards and obliquely downwards and outwards; they become fleshy half-way from their origin, and are inserted into the posterior oblique and transverse processes of the six anterior dorsal vertebrae, and into the posterior oblique processes of the three last cervical vertebrae.

Interspinales (Pl. XII, fig. 3. s).—The interspinales muscles do not exist in the region of the back, unless we regard the preceding oblique fibres as a modified representation of them. The most posterior fasciculus of muscular fibres, which is directly extended between the spinous processes, commences at the interspace of the spines of the two last cervical vertebrae, and the series is continued as far as the vertebra dentata.

Interarticulares (Pl. XII, fig. 3. t).—The muscles which form the more direct continuation of the obliquo-spinales are continued from the posterior oblique or articular processes of one vertebra to the posterior articular process of the next in front.

Obliquo-transversales (Pl. XII, fig. 3. v).—A third series of deep-seated intervertebral muscles is situated external to the preceding, and passes obliquely between the upper transverse process and the posterior articular process of the vertebra in front. These fasciculi appear to be a continuation of the multifidus spinæ in the neck.
Intertransversales (Pl. XII, fig. 3, w).—These are two series of short carneous fasciculi passing the one between the upper, and the other between the lower transverse processes.

Levatores costarum (Pl. XII, fig. 3, x).—The first or most anterior of this series of muscles seems to represent the scalenus medius (x*); it arises from both the upper and lower transverse processes of the last cervical vertebra, and expands to be inserted into the first rib, and into the upper and outer part of the second rib. The remaining levatores successively diminish in size as they are placed backwards; they come off from the transverse processes of the first six dorsal vertebrae; those from the first and second expand to be inserted into the rib attached to the same transverse process and to the one next behind; the rest have a single insertion: the angle and the part of the rib immediately beneath are the situations of their attachments.

Complexus (Pl. XI, XIII, fig. 1, y).—This strong triangular fleshy muscle arises from the articular and upper transverse processes of the fourth, third and second cervical vertebrae, and gradually expands as it advances forwards to be inserted into the occipital ridge, from the outer side of the insertion of the biventer cervicis to the mastoid process.

Recti capitis postici.—These small muscles are concealed by the preceding; they rise successively from the spines of the third, second and first cervical vertebrae, and expand as they advance to be inserted into the occiput.

Trachelo-mastoideus (Pl. XIII, fig. 1, z).—This strong, subdepressed carneous muscle arises from the upper transverse processes of the fifth, fourth, third and second cervical vertebrae, and is inserted into the side of the base of the occiput.

B. In Front of the Neck.

Longus colli (Pl. XIII, fig. 2, & XIV, a).—This large and long muscle, which appears simple when first exposed, as in Pl. XIII, fig. 2, is found to consist, when unravelled by further dissection, of a series of closely succeeding long, narrow fasciculi, arising from the hæmapophyses of the sixth dorsal to the first dorsal and from the ten posterior cervical vertebrae (Pl. XIV. a a); and sending narrow tendons (ib. a*) which increase in length as they are given off more anteriorly, obliquely forwards and outwards, to be inserted into the costal processes of all the cervical vertebrae save the first two: the highest or foremost tendon (ib. a**) is attached to the tubercle at the under part of the ring of the atlas; but this tendon is also the medium of insertion of five small fasciculi of muscular fibres (Pl. XIV, fig. 2, a**) arising from the upper transverse processes of the sixth, fifth, fourth, third and second cervical vertebrae.

The Rectus capitis anticus major (Pl. XIV, b) is continued, or arises by as many distinct tendons, from the five superior tendons of insertion of the preceding muscle; these origins soon become fleshy, converge, and coalesce previous to their insertion into the base of the skull.
The *Rectus capitis anticus minor* (Pl. XIV, c) is a strong fleshy compressed triangular muscle arising from the anterior part of the body of the first four cervical vertebrae. *Ins.* Base of occiput.

The *Rectus capitis lateralis* (Pl. XI, XIV, d) arises from the upper transverse processes of the sixth to the second cervical vertebra inclusive. *Ins.* Side of the base of the skull.

C. Muscles of the Tail.

*Levator caudæ.*—*Origin.* From the posterior and superior extremity of the ischium. *Ins.* Into the spines of the caudal vertebrae.

*Adductor caudæ superior.*—This muscle is smaller than the preceding, with which it runs parallel; it rises below from the posterior extremity or tuber of the ischium, and is inserted into the transverse processes of the caudal vertebrae.

*Adductor caudæ inferior.*—*Origin.* From the tuber ischi, and the ligament connecting this with the posterior extremity of the pubis. *Ins.* Into the transverse processes of the caudal vertebrae.

*Depressor caudæ.*—*Origin.* From the under part of the middle line of pelvis. *Ins.* Into the inferior spines of the caudal vertebrae.

D. Muscles of the Abdomen.

*Obliquus externus abdominis* (Pl. XI, XIV, e).—*Origin.* Fleshy, from the second and third ribs, and by a strong aponeurosis from the succeeding ribs near the attachment of the costal processes, and from those processes. *Ins.* The fleshy fibres are continued from this aponeurotic origin to nearly opposite the ends of the vertebral ribs; they run almost transversely, very slightly inclined towards the pubis, to within half an inch of the linea alba, and there terminate, by an almost straight, parallel line, in their aponeurosis of insertion. The fibres of this aponeurosis decussate those of the opposite side, and adhere to the tendinous intersections of the *rectus* beneath. The aponeurosis from the last rib passes to be inserted into a strong ligament extending between the free extremities of the *ossa pubis*, leaving the abdomen behind the last rib, defended only by the *internal oblique* and *transversalis*.

*Obliquus internus abdominis* (Pl. XIV, f).—*Origin.* From the whole of the anterior and outer surface of the pubis; aponeurotic from the upper part, fleshy for half an inch from the lower or ventral extremity: the carneous fibres run longitudinally, and cannot be distinctly defined from the *intercostales* on their outer border, or from the *rectus abdominis* on their inner or mesial border, which forms the medium of the insertion of the internal oblique.

*Rectus abdominis* (Pl. XIV, g).—I give this name to the mesial continuation of the preceding muscle, which arises by a strong, flat, triangular tendon (g) from the lower or
ventral extremity of the pubis and from the inter-pubic ligament: it soon becomes fleshy; the carnosous portion is interrupted by three broad, oblique, but distinct aponeurotic intersections (g*), and is finally inserted into the xiphoid and lateral processes of the sternum and the intervening fascia.

**Transversalis abdominis.**—A layer of loose, dark-coloured cellular tissue divides the internal oblique from the transverse abdominal, except at its origin from the pubis, and for half an inch anterior to that part.

The transversalis then proceeds to derive carnosous fibres from the inner surface of the vertebral ribs near their lower third; they pass obliquely upwards and forwards, and terminate by a regular, slightly concave line midway between their origins and the extremities of the ribs; a strong aponeurosis passes thence to the linea alba, but becomes thin at the pubic region, where a mass of fat is interposed between it and the peritoneum.

**Diaphragm (Pl. VI).**—This muscle presents more of its normal mammalian character in this than in any other known bird. It is perforated by vessels only, in consequence of the non-development of the abdominal air-cells. The origin corresponding to that of the lesser muscle in Mammalia is by two strong and distinct, short tendinous pillars (a a), from the sides of the body of the last costal vertebra; they are united by a strong tendon or fascia, forming the anterior boundary of the aortic passage. The tendinous pillars may be traced forward for some way in the central aponeurosis, expanding without crossing; they are then lost in that aponeurosis, which is perforated by the gastric arteries and veins; decussates and divides anteriorly (at b) to give passage to the gullet and the apex of the heart; the aponeurosis expands over the anterior part of the thoracic air-cells, and becomes, at its lateral circumference, the point of attachment of muscular fibres arising from the inner surface of the anterior ribs, and forming apparently a continuation of the transversalis abdominis.

**Appendico-costales (Pl. XI, h).**—**Origin.** From the posterior edge and extremity of the costal processes or appendages. **Ins.** They run down to be inserted severally into the rib posterior to that to which the process affording them origin is attached. These processes are supported by strong triangular aponeuroses continued from their anterior and upper margins, severally, to the rib anterior to them.

The muscles of the jaws have already been described in the account of the digestive organs. The following are shown in Pl. XI.: α, temporalis externus; β, temporalis internus; γ, biventer maxillæ; the masseter has been removed, but is shown at η, Pl. XIII. fig. 1. The internal pterygoid muscle is shown in Pl. XIV. at ε; the external pterygoid at ζ.

Some of the muscles of the tongue, which are described in the first part of this memoir (p. 8), are delineated in Plate XIII. fig. 1.

The strong orbicularis palpebrarum has been divided and reflected forwards at δ, Pl. XI.; it is shown *in situ* at fig. 1. Pl. XIII.
Muscles of the Anterior Extremity.

Serratus magnus anticus (Pl. XI, XIII, i).—This muscle consists of three portions; the first and anterior portion (Pl. XIII, fig. 2, i) arises by a short, strong aponeurosis from the last cervical rib, and is inserted into the lower edge of the anterior two-thirds of the scapula: the second and middle portion arises from the lower end of the second vertebral rib, near the attachment of the costal process, and from the anterior margin of the same rib, and is inserted into the lower edge of the posterior two-thirds of the scapula: the third, posterior and smallest portion (Pl. XI, i) rises from the costal process of the third rib, and ascends to be inserted into the posterior extremity of the scapula.

This muscle is a direct inspirator: by drawing down the scapula it depresses the sternum through the medium of the strong coracoideum, increases the angle between the vertebral and sternal ribs, and dilates the thoracic air-cells.

Levator scapulae (Pl. XI, XIII, k).—This seems to be the most anterior portion of the series of muscles which constitute the serratus magnus. Origin. Two flat fleshy strips from the inferior transverse and costal processes of the last and penultimate cervical vertebrae. Ins. Into the inner and upper side of the middle third of the scapula. It depresses as well as draws forwards the scapula, and thus aids the serratus in the action of inspiration.

Serratus anticus minor.—Origin. From the outer part of the costal process of the sternum. Ins. Into the posterior part of the base of the coracoideum.

Trapezius (Pl. XIII, l).—This flattened oblong quadrilateral muscle arises from the fascia, extending upon the back from the spinous processes of the posterior cervical vertebrae, and is inserted into the conjoined extremities of the scapula and coracoideum.

There is no representative of the rhomboidei.

Latissimus dorsi (Pl. XIII, m).—This muscle consists, as usual in Birds, of two portions, both of which have their origin from a continuation of the fascia, attached to the spinous processes, which gives attachment to the trapezius: the fibres of the smaller and anterior strip converge to their insertion: the fibres of the posterior and broader strip are slightly twisted, the posterior edge being folded inwards as they also converge to join the preceding, and to be inserted with it into the posterior and inner side of the proximal extremity of the humerus.

Deltoides (Pl. X, XIII, n).—This is a single long and narrow triangular muscle, of which the base is attached to the conjoined extremities of the scapula and coracoideum, and to the capsule of the shoulder-joint; the apical insertion is into the upper and outer third of the humerus, which this muscle directly raises.

Infraspinatus (Pl. XI, o').—A muscle which may be compared either to the infraspinatus or teres major comes off from the lower margin of the anterior two-thirds of the scapula, passes behind the shoulder-joint, where it is closely attached to the capsule, and is inserted into the inner and posterior part of the proximal end of the humerus.

Musculi pectorales.—The pectoral muscles, which present their feeblest condition and
lowest development in the Apteryx, are nevertheless similar in number and arrangement to those which in some birds of flight are known to outweigh all the other muscles of the body.

The pectoralis major (Pl. X, XI, XIII, XIV, p) is represented by two very thin triangular layers of muscular fibres, the anterior of which is three lines broad at its base, and is attached to the sternum immediately exterior to the perforation of that bone: the second, posterior, and somewhat narrower portion, rises immediately behind the preceding, from the osseous bridge separating the perforation from the notch; the two portions converge as they extend upwards and outwards to unite and be inserted into the anterior and internal surface of the proximal third of the humerus.

The pectoralis medius seu secundus (Pl. XI, XIV, q) is a similar, thin, feeble, but broader triangular layer of carneous fibres, which arise anterior to the preceding, just below the coracoid socket of the sternum, and converge as they wind over the shoulder-joint to be inserted into the upper surface of the proximal extremity of the humerus, of which they thus become an elevator.

The pectoralis minor seu tertius (Pl. XI, XIV, r) arises above and between the origins of the pectoralis secundus and the anterior strip of the pectoralis major, also partly from the coracoid process; its fibres converge to be inserted into the proximal end of the humerus, above and behind the pectoralis major.

Coraco-brachialis (Pl. XIV, s).—This is represented by two small strips of muscular fibres which rise from the posterior part of the coracoid, and are inserted, one directly below the other, into the proximal third of the humerus.

Obs.—The close adherence to the ornithic type of the muscular system of the anterior extremity in the Apteryx is more especially remarkable as regards the position and course of the pectoralis medius, since the physiological conditions of the circumstances attending that muscle are wanting in the Apteryx.

Here we have a true bird, exhibiting a remarkable modification of the whole ornithic structure, in reference to exclusively terrestrial life and nocturnal habits; and we learn, from this adherence to a typical organization, in a very rare exception, that the teleological conclusions respecting that typical construction, as it is manifested in the general rule, are in no ways affected by such an exception; because the modification of one part necessarily affects that of many others, perhaps of the whole body. If, for example, the fixation and structure of the lungs require a broad sternum and concomitant modifications of the coracoid and scapula for the mechanical part of the respiratory process, then it may be more convenient for the levator of the humerus to rise below that bone from the sternum, and act in the due direction by a modification of its course; although the locomotion of the bird may in no way be facilitated by the aggregation of muscular substance beneath the centre of gravity, nor the size of the levator be such as to render its particular position a matter of any consequence in regard to that centre.

A minute flexor (Pl. XIII, fig. 2, t), wanting the attachment to the scapula which exists in birds of flight, and arising solely from the humerus, glides along the front of that bone, chiefly as a delicate tendon to be attached to the inner part of the head of the ulna.
A single extensor (Pl. XIII. fig. 1. v), almost equally tendinous and delicate, arises from the scapula, and represents the 'long extensor' of Vicq. d'Azyr: it is inserted into the rudimental olecranon.

There is a tendinous trace of a flexor (w) and extensor (x) of the minute monodactyle manus: but the motions of the rudimental wing and its terminal hook would seem to be produced as much by the cutaneous muscles which converge to be inserted into the integument connected with it, as by the feeble representatives of the true wing-muscles above described.

**Muscles of the Posterior Extremity.**

The most superficial of the muscles on the outer side of the leg is that very broad one which combines the functions of the tensor vaginæ and rectus femoris, but which, in the opinion of both Cuvier* and Meckel†, is the homologue of the tensor vaginæ and glutæus maximus (seu externus); since however it is exclusively inserted into the leg, I shall describe it with the other muscles moving that segment of the posterior extremity. The removal of this muscle, of the sartorius, and the biceps cruris, is requisite to bring into view the true glutæi.

**Glutæus externus** (Pl. XI. A).—The external glutæus (glutæus medius of Meckel) is smaller, as in most Mammalia, than the middle glutæus, but is relatively larger in the Apteryx than in birds of flight, in which it is described as the pyriformis by Cuvier‡. This muscle, however, besides its origin from the outside of the pelvis, overlaps part of the glutæus medius, and has its insertion into the femur at some distance below the great trochanter, all of which are marked characteristics of the glutæus magnus. **Origin.** It takes its origin from the superior margin of the os innominatum, extends along an inch and a quarter of that margin, directly above the hip-joint, and is chiefly attached by distinct short tendinous threads, which run down upon the external surface of the muscle: it rises also by carneous fibres from the external surface of the os innominatum for three lines below the superior margin. **Insertion.** The fibres converge and pass into a tendinous sheet, beginning on the external surface of the muscle half-way down its course, which ends in a broad, flat, strong tendon, inserted into a rising on the outer side of the femur nearly an inch below the great trochanter. It abducts and raises the femur.

**Glutæus medius** (Pl. XI. b).—**Origin.** This is the large, triangular, strong and thick muscle, which has an origin of three inches' extent from the rounded anterior and superior margin of the ilium, and from the contiguous outer surface of the bone for an extent varying from an inch to eight lines. **Ins.** Its fibres converge to a strong, short, broad and flat tendon, implanted in the external depression of the great trochanter, having a bursa mucosa interposed between the tendon and the bony elevation anterior to the depression.

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† Vergleich. Anat. 1828, Th. iii. p. 361.
‡ Loc. cit. p. 503; it is here called 'pyramidal.'
Gluteus minimus (Pl. XI. c).—Origin. It rises below and internal to the preceding muscle from the anterior and inferior extremity, and from one inch and three-fourths of the inferior and outer margin of the ilium, and contiguous external surface, as far as the origin of the gluteus medius; also by some fleshy fibres from the outside of the last rib. Ins. These fibres slightly converge as they pass backwards to terminate in a broad flat tendon which bends over the outer surface of the femur, to be inserted into the elevation anterior to the attachment of the gluteus magnus.

A muscle (Pl. XI. d.) which may be regarded either as a distinct accessory to, or a strip of the preceding one, arises immediately behind it from half an inch of the outer and inferior part of the ilium; its fibres run nearly parallel with those of the gluteus minimus, and terminate in a thin flat tendon, which similarly bends round the outer part of the femur, to be inserted into the outer and under part of the trochanter immediately below the tendon of the gluteus medius. This muscle and the preceding portion, or gluteus minimus, are described by Prof. Mayer* under the names of Gluteus quartus and Gluteus quintus, in the Cassowary; one of them is absent in most birds.

Use.—All the preceding muscles combine to draw the femur forwards, and to abduct and rotate it inwards.

Iliacus internus.—This is a somewhat short thick muscle, of a parallelogrammic form, fleshy throughout; rising from the tuberosity of the innominatum in front of the acetabulum immediately below the gluteus minimus, and inserted at a point corresponding to the inner trochanter, into the inner side of the femur near the head of that bone, which it thus adducts and rotates outwards. This muscle is present both in the Ostrich and Bustard, but Meckel† says it is wanting in the Cassowary.

Pyramidalis.—The same kind of modification which affects the iliacus internus, viz. the displacement of its origin from the inner surface of the ilium to a situation nearly external, affects this muscle, which, from its insertion and triangular form, I regard as the analogue of the pyramidalis. It arises fleshy from the outer surface of the ilium for the extent of an inch, and converges to a broad flat tendon which is inserted into the trochanter femoris opposite, but close to the tendon of the gluteus minimus, which it opposes, abducting and rotating the femur outwards.

Adductor brevis femoris (Pl. XI. e).—A small, long and slender muscle arises from the innominatum immediately behind the acetabulum, passes over the back part of the great trochanter, becomes partially tendinous, and is inserted into the back part of the femur in common with the following muscle.

Adductor longus (Pl. XI. XIV. f).—A long, broad and thin muscle, separated from the preceding by the ischiadic nerve and artery. The origin of this muscle extends one inch and a quarter from near the upper margin of the innominatum which is behind the acetabulum; it is joined by the preceding strip, and is inserted into the whole of the lower two-thirds of the back part of the femur.

† Arch. fur Physiol. xiii. 261.
Adductor magnus (Pl. XIV, 6).—This broad and flat muscle has an extensive origin (two inches) from the outer edge of the ischium and the obturator fascia; its fibres slightly diverge as they pass downwards to be inserted into the back part of the lower half of the femur, and into the upper and back part of the tibia.

Obturator internus.—This arises from the inner side of the opposite margins of the pubis and ischium, where they form the posterior boundary of the obturator foramen, and from the corresponding part of the obturator fascia; the fleshy fibres converge in a slightly penniform manner to the strong round tendon which glides through the notch, separated from the rest of the foramen by a short, strong, transverse, unossified ligament, and is inserted into the posterior part of the base of the trochanter. In its length and size this muscle resembles the corresponding one in the Ostrich and other Struthious birds.

Gemellus.—This is represented by a single small fleshy strip arising from the margin of the obturator foramen, close to the emergence of the tendon of the obturator internus, with which it is joined, and co-inserted into the femur.

Quadratus.—I consider a broad fleshy muscle which arises from the pubis, below the obturator foramen, and which increases in breadth to be inserted into the femur internal and posterior to the obturator tendon, to be the true analogue of the quadratus femoris.

Tensor vaginae and Rectus femoris (Pl. X, II).—The largest and most remarkable of the muscles which act upon the bones of the leg is that already alluded to as the most superficial of those on the outer side of the thigh. It has a broad, thin, triangular form, and arises from the spines of the sacrum by a strong but short aponeurosis which soon becomes fleshy; the carnaceous fibres converge as they descend*, and pass into a thin aponeurosis at the lower third of the thigh: this is closely attached to the muscles beneath (vastus externus and cruræus), then spreads over the outer and anterior part of the knee-joint, is inserted into the patella, and into the anterior process of the head of the tibia.

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

Sartorius (Pl. X, XIV, 1).—The origin of this muscle is characterized by an unusual extension, like that of the preceding, with which it is posteriorly continuous: it comes off aponeurotic, from the anterior and superior margin or labrum of the ilium; the fibres soon become fleshy, and the muscle diminishes in breadth and increases in thickness as it descends: it is inserted by short and strong tendinous filaments obliquely into the

* They are not divided into a superficial and deep layer, as in the Ostrich, but form a simple stratum, as in the Cassowary. Meckel regards the rectus as entirely wanting in the Cassowary, supposing, with Cuvier, the present muscle to be the analogue of the gluteus maximus and tensor vaginae united. He says that Professor Nitzsch observed a like absence of the rectus femoris in the Emu. Cuvier calls that muscle rectus anticus femoris, which is described in this monograph as the 'pectineus.'
anterior part of the tendon of the broad rectus, and into the anterior and inner part of
the head of the tibia. Its insertion is partly covered by the internal head of the gastro-
cnemius.

It bends and adducts the thigh, and extends the leg.

The homologue of the Biceps flexor cruris (Pl. X, XI, k) is a unicipital muscle, cor-
responding with the rectus extensor in the characteristic modification of its extended
origin, in relation to the great antero-posterior development of the pelvic bones: it is
exposed by the removal of the rectus. Orig. By a broad and thin aponeurotic tendon,
which at first is confluent with that of the rectus but soon becomes distinct, from the
posterior prolongation of the ilium: there is no second head from the femur. Ins. The
fleshy fibres converge as they descend along the back and outer part of the thigh, and
finally terminate in a strong round tendon, which glides through a loop (x) formed, as
in the common Fowl, Ostrich, &c., by a ligament extended from the back of the outer
condyle of the femur to the head of the tibia, and is inserted into the process on the out-
side of the fibula one inch from its proximal extremity. By means of the loop the weight
of the hinder parts of the body is partially transferred, when the leg is bent, to the
distal end of the femur; and the biceps is enabled, by the same beautiful and simple
mechanism, to effect a more rapid and extensive inflection of the leg than it otherwise
could have produced by the simple contraction of its fibres.

Semimembranosus (Pl. XI, XIV, l).—Origin. From the side of the coccygeal vertebæ,
and from the posterior end of the ischium; it crosses the superficial or internal side of
the semitendinosus. Ins. Into the fascia covering the gastrocnemius and the inside of the
tibia: through the medium of the fascia it acts upon the tendon (r*) of the internal
gastrocnemius.

Semitendinosus (Pl. XI, XIV, m).—This muscle arises from the posterior and outer
part of the sacrum and the aponeurosis connecting it with the ischium: it is a flattened
triangular muscle, which receives the square accessorius muscle (x) from the lower and
posterior part of the femur. It gradually diminishes as it descends, and having passed
the knee-joint, sends off at right angles a broad and square sheet of aponeurosis, which
slides between the two origins of the gastrocnemius internus, and is inserted into the
lower part of the angular ridge continued from the inside of the head of the tibia. The
terminal tendon, continued from the apex of the muscle, then runs along the outer or
fibular margin of the internal head of the gastrocnemius, and becomes confluent with the
tendon of that muscle at r* Pl. XIV.

Cruræus (Pl. XI, XIV, o).—This is a simple but strong muscle: it commences at the
upper and anterior part of the thigh by two extremities, of which the outer and upper
one, representing the vastus externus, has its origin extended to the base of the tro-
chanter; the inner and inferior comes off from the inner side of the femur, beneath the
insertion of the glutæus magnus; the two portions blend into one muscle much earlier than
in the Ostrich. Ins. By the ligamentum patellæ into the fore-part of the head of the tibia.
Gracilis (Pl. XIV. r).—On the inner side of the cruraeus, but more superficially, lies a narrow, compressed, long muscle, which rises by two heads, one from the anterior and upper part of the femur, the other from the os pubis; both soon become blended together and transmit a broad thin tendon to be inserted into the lower and lateral part of the patella with the cruraeus.

Vastus internus (Pl. XIV. q).—Two other muscles succeed the preceding, and rise beneath it from the inner and anterior part of the femur; they have a similar insertion, and obviously represent the vastus internus. The fibres converge to a middle aponeurosis, which increases to a strong short tendon, inserted into the upper and anterior projection of the tibia.

Popliteus.—This small muscle is brought into view when the superficial muscles of the leg which are inserted into the foot are removed. Its carneous fibres extend from the fibula inwards and downwards to the tibia. It is of relatively smaller extent than in the Cassowary.

Gastrocnemius.—This complex and powerful muscle consists, as in other birds, of several distinct portions, the chief of which correspond with the external and internal origins of the same muscle in the Mammalia. The gastrocnemius externus (Pl. X, XI r) arises by a strong, narrow, rather flattened tendon (r *) from the ridge above the external condyle of the femur, which, about an inch below its origin, becomes firmly attached to the strong ligamentous loop attached by one end to the femur above the preceding tendon, and by the other to the outer ridge of the fibula. This trochlear loop, which is displayed by reflecting down the tendon of the gastrocnemius in Pl. XI, is lined by synovial membrane, and supports the tendon of the biceps cruris, which glides through it. The carneous fibres of the external gastrocnemius come off from the outer side of the tendon, and from the fascia covering the outer surface of the muscles of the leg: they are continued in a somewhat penniform arrangement two-thirds down the leg, upon the inner surface of the muscle, where they end in a strong subcompressed tendon. This joins its fellow-tendon, from the internal gastrocnemius, behind the ankle-joint, and both expand into a thick, strong ligamentous aponeurosis (Pl. XI, fig. 2, r), which extends over three-fourths of the posterior part of the tarso-metatarsal bone. The lateral margins of this fascia are bent down under the flexor tendons behind the joint, and become continuous with a strong ligamentous layer gliding upon the posterior surface of the distal condyles of the tibia, and attached to the tendons of the peroneus and tibialis anticus: the conjunction of the thickened tendons of the gastrocnemii with this deeper-seated layer of ligamento-tendinous substance constitutes a trochlear sheath (Pl. XIV. r *** ) lined by synovial membrane, through which the flexor tendons of the toes glide. The synovial membrane of the ankle-joint is continued upwards half an inch above the articular surface of the bone, between it and the fibro-cartilaginous pulley. Below the joint the margins are inserted into the lateral ridges of the tarso-metatarsal bone, becoming gradually thinner as they descend, and ending below in a thin semilunar edge directed downwards.
The **gastrocnemius internus** (Pl. XIV. r) has two powerful heads, one from the femur; the other from the tibia; the first (R)† arises fleshy from the internal condyle of the femur, expands as it descends, and receives additional fibres from the lower edge of the **accessorius semitendinosi**. About one-fifth down the tibia this muscular origin in the right leg terminated in a flattened tendon (R*), which became attached to the inner side of the tibial portion of the **gastrocnemius internus** (R**). In the left leg the tendon soon divided; one portion passed to the soleus, the other went to join the tibial portion of the **gastrocnemius internus**. The second head, which is separated from the preceding by the insertion of the **semitendinosus**, arises partly from the internal and anterior part of the strong fascia of the knee-joint by short tendinous fibres, which almost immediately become fleshy, and partly from a well-defined triangular surface (R**) on the inner and anterior aspect of the head of the tibia: the fleshy fibres converge, receive the tendinous slip from the femoral portion, and end on the inner side of the muscle in a strong flattened tendon, about two-thirds down the leg; this joins the tendon of the **gastrocnemius externus** (r e), and is inserted as described above.

**Soleus** ‡ (Pl. XIV. s).—This is a slender flattened muscle arising from the posterior part of the head of the tibia, the tendon of which joins that of the **gastrocnemius internus**, behind the tarsal joint.

The **Flexor perforans digitorum** (Pl. X. XI. XIV. 1) lies immediately anterior to the external **gastrocnemius**; it arises fleshy from the outer condyle of the femur, below the tendinous origin of that muscle, and terminates in a slender flat tendon half-way down the leg. Its tendon (1) glides behind the tarsal joint through the sheath of the **gastrocnemius**, expands beneath the metatarsus and bifurcates, sending its smallest division to the inner toe, and its larger one to blend with the tendon of the **peroneus longus**.

**Flexor perforatus** of the outer toe (Pl. X. XI. XIV. 2).—This arises by very short tendons from the proximal end of the fibula, and from the ligament forming the bicipital pulley; it continues to derive a thin stratum of fleshy fibres from the fascia covering the anterior surface of the muscles of the leg: the fleshy fibres terminate half-way down the leg in a flattened tendon, which, after entering the gastrocnemial sheath, pierces the tendon of the first perforatus of the middle toe, then runs forward to the outer toe, expands into a thick ligamentous substance beneath the proximal phalanx, and sends off two tendinous attachements on each side, one to the proximal, the other to the second phalanx, and is continued to be finally inserted into both sides of the third phalanx.

**Flexor perforatus digitorum** (Pl. XI. XIV. 3, 4, 5, 6) is the strongest of the three; it arises fleshy from the posterior part of the distal extremity of the femur, above the external condyle (Pl. XI. 4), and also by a distinct flattened tendon (6), one inch in length,

† This is described as the *soleus* in the Cassowary, by Prof. Mayer, *loc. cit.* p. 15, but the origin of this muscle is not extended in other animals above the knee-joint.

‡ This is described as the *plantaris* in the Cassowary, by Prof. Mayer, *loc. cit.* p. 14, but the normal origin of that muscle should be sought for above the knee-joint.
from the proximal end of the tibia: this tendon moreover receives the long slender tendon sent off obliquely across the front of the knee-joint from the pectineus (t), by which its origin is extended to the pelvis. This accessory tendon perforates the inner fleshy surface of the muscle, and is finally lost about half-way down the carneous part. Before the flexor perforatus is joined by the tendon of the pectineus, it subdivides posteriorly into four muscular fasciculi. The anterior division receives principally the above tendon, and this division of the muscle becomes wholly tendinous two-thirds down the leg; its tendon (3) passes through the posterior part of the pulley of the gastrocnemius, and expands as it passes along the metatarsus: a thick ligamentous substance is developed in it opposite the joint of the proximal phalanx of the second toe, into the sides of which it is inserted, dividing for that purpose, and giving passage to the two other flexor tendons of that toe. The second portion of the present muscle terminates in a tendon (4) situated behind the preceding, which passes through a distinct sheath behind the tarsal joint, expands into a sesamoid fibro-cartilage beneath the corresponding expansion of the previous tendon, which it perforates, and then becomes itself the perforated tendon of the second phalanx of the second toe, in the sides of which it is inserted. The third portion of this muscle ends in a somewhat smaller tendon (5) than the preceding, which forms the second perforatus flexor of the third or middle toe. The fourth and most posterior portion soon becomes a distinct muscle; its fleshy fibres cease on the inner side, one-fourth down the leg, but on the outside they are continued three-fourths down the leg; its tendon (6) passes through the gastrocnemial pulley behind the ankle-joint, and divides to form a sheath for the flexor perforatus of the fourth toe; it is then joined by the tendon of the peroneus (7), which passes through a pulley across the external malleolus, and finally becomes the perforated tendon of the first phalanx of the middle or third toe.

Pectineus (Pl. XI, XIV. t), (Rectus anticus femoris of Cuvier* and Meckel†).—This is a long, thin, narrow strip of muscle arising from the spine of the pubis, anterior to the acetabulum, and passing straight down the inner side of the thigh; it degenerates into a small round tendon near the knee, which tendon traverses a pulley, formed by an oblique perforation in the strong rotular tendon of the extensors of the leg, and thus passing across the knee-joint to the outer side of the leg, finally expands, and is lost in the flexor perforatus digitorum last described. It is this muscle which causes the toes to be bent when the knee is bent.

Peroneus longus (Pl. XI, XIV. 7).—Origin. Tendinous from the head of the tibia, and by carneous fibres from the upper half of the anterior margin of the tibia; these fibres pass obliquely to a marginal tendon, which becomes stronger and of a rounded form where it leaves the muscle. The tendon gives off a broad, thin, aponeurotic sheath to be inserted into the capsule of the tarsal joint; it is then continued through a synovial pulley on the side of the outer malleolus, and is finally inserted or continued into the perforated tendon of the middle toe (6).

Tibialis anticus (Pl. XI, XIV. 8).—This muscle is overlapped and concealed by the peroneus; it arises partly in common with that muscle, and partly by separate short tendinous threads from the outer part of the head of the tibia; it gradually becomes narrower, and finally tendinous two-thirds of the way down the leg; its strong tendon glides through the oblique pulley* in front of the distal end of the tibia, expands as it passes over the ankle-joint, and is inserted into the anterior part of the proximal end of the tarso-metatarsal bone, sending off a small tendinous slip to the aponeurosis covering the extensor tendons of the toes, and a strong tendon (8') which joins the fibular side of the tendon of the following muscle.

Extensor longus digitorum (Pl. XIV. 9).—This lies between the tibialis anticus and the front and outer facet of the tibia, from which it derives an extensive origin; its tendon commences half-way down the leg, runs along the anterior part of the bone, first under the broad ligamentous band representing the anterior part of the annular ligament, then through a ligamentous pulley, and inclines to the inner or tibial side of the anterior surface of the metatarsal bone, where it expands and divides into three tendons. Of these the innermost is given off first, and subdivides into two tendons, one of which goes to be inserted into the base of the last phalanx of the second toe; the other portion is principally inserted into the middle toe, but also sends off a small tendon to the inner side of the proximal phalanx of the second toe. The second tendon is inserted by distinct portions into the second, third and last phalanges of the middle toe. The third tendon supplies the outer toe.

Extensor brevis digitorum (Pl. XIV. 10).—A small extensor muscle arises from the insertion of the tibialis anticus, and sends its tendon to the outer side of that of the great extensor digitorum.

Extensor pollicis brevis (Pl. XIV. 11).—An extensor of the small innermost toe arises from the upper and inner side of the tarso-metatarsal bone.

Peroneus medius, Cuv., Accessorius flexoris digitorum, Vicq. d’Azyr (Pl. XI, XIV. 12).—This strong penniform muscle arises fleshy from nearly the whole of the outer surface of the fibula, also from the posterior part of the tibia and the interosseous space; the tendon of the biceps perforates its upper part in passing to its insertion. It ends in a strong flat tendon at the lower third of the leg, which tendon runs through a particular sheath at the back part of the tarsal pulley, becomes thickened and expanded as it advances forwards beneath the tarsus, joins the tendon of the flexor perforatus (1), and forms with it the expansion which finally divides into three strong perforating tendons, which bend the last joints of the three long toes.

In the outer, or fourth toe, both the perforans and perforatus tendons are confined by a double annular ligament; the exterior one being continued from the adjoining toe, the inner and stronger one from the sides of the proximal phalanx of the outer toe.

* This is ossified in the Bustard and most true Gralla.
The second and third toes have two perforated tendons; one inserted into the sides of the first, and the other into the sides of the second phalanx.

On a review of the details of the Muscular System above recorded, it will be seen that the analogies of the muscles on the dorsal aspect of the spine with those of Man and the Mammalia, are, in consequence of their unusually strong and distinct development in the Apteryx, more clearly traceable than their condition in other birds perhaps admits of. The same character of the muscles of the hind-extremity has led, as I believe, to a more accurate determination of them than had been adopted by former Comparative Anatomists, among whom the honoured names of Cuvier and Meckel call for a more detailed statement of the grounds on which I have ventured to dissent from views, so sanctioned, than has been given in the descriptive part of the present monograph.

The chief modification of the skeleton of the hind limb of Birds, in respect of size and proportion, is manifested in its central segment; theossa innominata being anomalously expanded in order to include, as it were, in their grasp the whole of the very long sacrum required for the support of the horizontal trunk upon a single pair of extremities. The principal modification of the muscles of the leg attached to theossa innominata might be expected, therefore, to be found in their origins. In the attachment of the fibres of a superficial muscle to the aponeurosis, continued from the outer part of the thigh, over the knee-joint, to the head of the tibia, we recognize the corresponding insertion of the tensor vaginae femoris of Man and Mammalia; and no Comparative Anatomist appears to have thought the anomalous development and extensive origin of this muscle, in Birds, to be any objection to the homology indicated by its insertion, which is the attachment that mainly governs the function of a muscle. Now besides the attachment to the femoral fascia, we find this broad superficial muscle, and especially its middle and posterior fibres, terminating in a strong tendon, implanted into the upper part of the patella, and receiving fibres from the cruræus and vasti muscles which it immediately covers, and with which it concurs in constituting a quadriceps extensor of the leg. Here, therefore, we perceive the normal insertion, the normal function, and the true relative position of the rectus femoris: and shall we reject these concordances on account of the modification of unusually extended origin? By parity of reason, we ought to reject the admitted homology of the tensor vaginae; and not only of this, but also of the sartorius and biceps cruris, both of which have undergone equal or greater modifications of origin in the class of Birds. It is true that the glutæus maximus is the most superficial of the outer muscles of the thigh in Man and Mammalia, and that it has the most extensive origin and largest size in Man; but superior size and extensive origin are far from being the characters of the glutæus externus in the lower Mammalia, in which it much more frequently
manifests the proportions, as compared with the *gluteus medius*, which the muscle to which I have assigned the name of *gluteus externus* in the Apteryx, presents. But if the *rectus femoris* has undergone, as I believe, a similar modification of origin to that which characterizes the *tensor vaginae, sartorius* and *biceps*, it would, by its extension along the spines of the sacrum, cover and mask the true *gluteus externus*, which arises from part of the outer surface as well as from the crista of the ilium; and by the same modification of the *rectus*, that connection between the *tensor* and *gluteus*, which is present in some quadrupeds, would be severed; while the more common close proximity of origin of the *rectus* and *tensor* is maintained. Already, in the Kangaroo, we find the origin of the *rectus femoris* extending from above the acetabulum higher up than usual upon the iliac bone. If, therefore, the great superficial muscle in question does not include the *rectus femoris* with the *tensor vaginae*, then, with the evidence of the true *gluteus externus* in the muscle a Pl. XI. of the Apteryx, I should feel bound to regard it as an enormous development of the *tensor vaginae* alone.

Meckel assigns as his reason for regarding the muscle which I have called *gluteus externus* to be the *gluteus medius*, that its origin and relations to the other levators and abductors of the thigh are absolutely the same as the *gluteus medius* in Mammals*. It is, he says, covered by the *gluteus maximus*, meaning a Pl. X., or the great 'pyramidal' of Vicq. d'Azyr; but we are not bound to admit, in the absence of proof, the assumption that the great pyramidal of Vicq. d'Azyr is the *gluteus maximus*; and until this be satisfactorily proved the argument is of no weight. I have already given reasons for regarding the *gluteus externus* of Meckel as the combined *tensor vaginae* and *rectus femoris*: the true *gluteus externus* is hidden in most birds, by the extraordinary extension of the origin of the *rectus extensor cruris* on one side, and of the *biceps flexor cruris* on the other; but though covered, the *gluteus externus* is the outermost of the three *glutei* which are recognizable in the 'Apteryx.' The more posterior position of its origin and its lower insertion, together with its inferiority of size as compared with the muscle which I have called *gluteus medius*, are characters which the *gluteus externus* of the Apteryx has in common with that muscle in most Mammalia, and especially in the genera *Macropus* and *Dipus*, which most resemble Struthious birds in the proportions and functions of their locomotive extremities.

To attempt to conceive this muscle to be the homologue of the *pyriformis* involves so anomalous an inversion of position in respect of the pelvis, of relations to other muscles inserted into the proximal part of the femur, and of both origin and insertion, as can only be accounted for by the difficulty in which Cuvier, having recognized the true *gluteus medius*, found himself in respect to the homologue of the *gluteus externus*, having applied the name of that muscle to the expanded *tensor* and *rectus*, by which it is covered.

The remarkable concordance of the muscles of the rudimental wing in the Apteryx

* Loc. cit. p. 352.*
with those in ordinary birds of flight, has been already pointed out. Nor is the correspondence less remarkable in the muscles of the leg and foot, especially as manifested in the condition of the 'perching muscle' (pectineus), in which it could hardly have been anticipated. The strong flexors and extensors of the leg and toes are strictly adapted to the exigencies of a bird which obtains probably most of its nourishment from the earth by means of feet resembling those of the Gallinacea, and which owes its safety to the speed with which it runs by means of legs which have the proportions of those of the Struthious tribe; and which, finally, is reported to seek concealment and to incubate in subterranean burrows.

Female Organs of the Apteryx australis.

The trunk of a specimen of this species, transmitted to me from New Zealand by the lamented botanist Mr. Cunningham, having proved to be that of a female, enables me to complete this anatomical monograph, by the description of the organs of generation in that sex. These consisted of two ovaria and one oviduct. The right ovarium was, as usual in Birds, in an atrophied state, and situated in front of the corresponding suprarenal body, attached to that body and the adjoining trunk of the vena cava. It was a small, flattened, minutely granular body, measuring eight lines by five lines, and about one line in thickness.

The left ovarium (Pl. XV. a) was in a state of full development, of the usual racemose structure, consisting principally of one enormous calyx (b), ripe for dehiscence, containing the vitellus of an ovum, which measured three inches in length by two inches in breadth, indicating an unusually large egg for the size of the bird. All the other calyces were comparatively small, and the greater number of minute size.

The oviduct commenced by the usual simple unfringed or entire slit-shaped aperture (c), two inches in its long diameter: the tube soon contracted to a diameter of half an inch, with longitudinally plicated walls, indicating its dilatability: it then expanded to an inch diameter, and after slightly contracting, suddenly enlarged, to form the uterine or shell-secreting part (d), which was nearly one inch and a half in diameter; here the muscular tunic is thicker, and the lining membrane presents a peculiar character, consisting of transverse, linear, sub-parallel streaks, sending off numerous short processes at right angles, both streaks and processes being of a white colour, relieved by the darker mucous membrane. A magnified portion of this structure is given at fig. 2. This structure occupied nearly two inches of the uterine dilatation, which reassumed the longitudinal plications about one inch before terminating in the uro-genital compartment of the cloaca. The terminal outlet (e) is of a narrow elliptical form, with a tumid margin covering a sphincteric arrangement of the muscular fibres.
DESCRIPTION OF THE PLATES.

PLATE I.

Fig 1. Head of a female *Apteryx*.
   a. The external nostril.
2. Head of a male *Apteryx*.
   a. The cere.
   b. The ear.
3. Head of a *Rhea Americana*.
   a. The cere.
   b. The ear.
4. The external appearance of the rudimental wing of the *Apteryx* when the feathers are removed: it exhibits the form of one of the abnormal small quill-feathers described at p. 3.
5. One of the neck-feathers of the *Apteryx*.

PLATE II.

Abdominal sacs of the *Apteryx*.

a. The right hepatic sac, with a style passing through the aperture of communication with
b. The right enteric sac.
b'. Another style, passing by the side of the stomach, into the left hepatic sac.
c. Omentum.
d. The pancreas.
e. The duodenum.
f. The fold of jejunum.
g. The rectum.
r. The external sphincter.
s. The penis.
a. The two portions of the *pectoralis major*.
ß. *Pectoralis medius*.

* Since the preceding pages were printed Mr. Cunningham has transmitted to the Zoological Society the skin and the trunk of an *Apteryx*, which proves to be a female, and has a beak measuring from the gape to the tip six inches four lines, thus verifying the conjecture put forth at p. 4, that the difference in the length of the beak is sexual, and that the longer one characterizes the female.
PLATE III.

Fig. 1. Under surface of the head of the *Apteryx*, with the tongue and palate exposed.
   a. The posterior nasal apertures.
   b. The common opening of the Eustachian tubes.
   c. The tongue.
   d. The *glottis*.
   e. The glandular processes of the pharyngeal membrane.

2. The inferior surface of the tongue and hyoid-bone, with the commencement of the *oesophagus* and *trachea*.

3. Abdominal *viscera in situ*.
   a. Gastric processes of *omentum*.
   b. *Omental* processes covering the intestines.
   c, c. *Omental* processes in the intestinal loops.
   d. The *pancreas*, in
   e. The *duodenal* loop.
   f. The first loop of *jejenum*.
   g. The *rectum*.
   h. The *oesophagus*.
   i. The *sterno-tracheales* muscles.
   j. The carotid arteries.
   k, k. The right and left lobes of the liver.
   n. *Erector penis*.
   o. *Compressor venarum penis*.
   p. Vascular and nervous *plexus*.
   q. Internal *sphincter of cloaca*.
   r. External *sphincter*.
   s. *Penis*: a probe is passed beneath it into the *cloaca*.
   t. *Coccygeal* gland.

PLATE IV.

Digestive, Urinary, and Male Generative Organs.

a. The *proventriculus*.
   b. The stomach.
   c. The *duodenum*.
   d. The *vitelline cæcum*.
   e, e. The two *caca*.
The rectum laid open, showing the large glandulae solitariae.

Bristles inserted into the ureters.

The papillae, on which the vasa deferentia terminate.

The penis.

The bursa Fabricii.

The right, and the left lobe of the liver.

The gall-bladder: two cyst-hepatic ducts are seen entering its cervix.

The cystic duct.

The hepatic duct.

The pancreas.

The spleen.

The renal veins;

Their posterior anastomosis, forming the commencement of the portal system of veins; and their anterior anastomosis, forming the commencement of the inferior vena cava, and completing the circulus venosus renalis.

The kidneys.

The ureters.

The supra-renal glands.

The testes.

The vasa deferentia.

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**PLATE V.**

**Fig. 1.** Part of the digestive system of Dr. Logan's female *Apteryx.*

The proventriculus laid open, showing the thickness of the glandular coat and the internal surface.

The gizzard, showing the internal projections produced by the state of contraction of the cavity.

The commencement of the duodenum, lined with thick epithelium.

The liver.

The duct corresponding with the cystic.

The hepatic duct.

The pancreas.

The orifices of the pancreatic ducts.

The pedicle or obliterated canal of the persistent vitelline sac.

The twig representing the omphalo-mesenteric artery.

2. A section of one of the ordinary bilobate proventricular glands. 3. A quadrilobate proventricular gland. Both twice the natural size.

4. Section of the right lung and air-sacs.
a. The *sterno-trachealis* muscle: bristles are seen passing from the external branch of the *bronchus* into the three anterior air-sacs.

Fig. 5. Front view of both lungs.

a. The anterior or short pulmonic bronchial tube.
b. The posterior or long pulmonic bronchial tube.
c. The bronchial tube of the air-sacs.

**PLATE VI.**

Fig. 1. A dissection, showing the *diaphragm* of the *Apteryx*.

a. The two *crura* of the vertebral portion or lesser muscle of the *diaphragm*.
b, β. Fasciculi of the costal portions of the *diaphragm*.
a. The *pericardium* covering the *apex* of the heart, and protruding through the anterior fissure of the *diaphragm*.
b. The *oesophagus*.
l. The trunk of the *coeliac* axis protruding through a *foramen* in the expanded central tendon of the *diaphragm*.
m. The mesenteric artery.
n. The abdominal *aorta*.
o. The spermatic artery.
p, p. The femoral arteries.
q, q. The renal arteries.
r, r. The ischiadic arteries.
s. The sacro-median artery.

Fig. 2. Front view of the heart.
a. The right ventricle.
b. The right auricle.
c. The pulmonary artery.
d. The *arteriae innominatae*.
e, e. The internal thoracic arteries.
f, f. The brachial arteries.
g. The carotids.

3. The heart, dissected, to show the interior of the right auricle and ventricle.
b. The inferior *vena cava*.
c. The left superior *cava*.
d. The right superior *cava*.
e & f. The semilunar valves, between the sinus and auricle.
g. The right auriculo-ventricular valve.
h. The left auricle.
PLATE VII.

Skulls of *Apteryx Australis* and *Numenius arcuatus*.

Fig. 1. Upper surface of the skull of the *Apteryx Australis*, male.
2. Under surface of the same.
3. Upper surface of the skull of the *Ibis (Numenius arcuatus)*.
4. Under surface of the same.
5. Posterior surface of the skull of the *Apteryx*.
6. Upper surface of the lower jaw of the male *Apteryx*.
7. Under surface of the same.
8. *Os hyoides*.

PLATE VIII.

Skeleton of the male *Apteryx*, one half the natural size.

PLATE IX.

Fig. 1. Under surface of the bony compages of the thoracic, abdominal, and pelvic cavities, with the *sternum* and sternal ribs removed.
2. Under or external surface of the *sternum*.
   a. The perforations*.
   b. The posterior fissures.
   c. The broad anterior emargination.
   d. The articular notch for the coracoid.
   e. The coracoid.
   f. The rudiment of an acromial clavicle.
   g. The *scapula*.
   h. The sternal ribs.
3. The upper or internal surface of the *sternum*.
   h. The articular cavities for the sternal ribs.
4. Posterior or internal surface of the anchylosed *scapula* and *coracoid*.

* In the skeleton of a half-grown *Apteryx* which I have received since the foregoing Memoir was printed, the sternum consists, as in the young Ostrich, of two symmetrical osseous plates, united at the middle line by cartilage. Neither of the lateral halves of this sternum was, therefore, perforated; and the structure of the sternum of the male *Apteryx* represented in Pl. IX. figs. 2 and 3 may prove to be a variety.
PLATE X.
Side view of the superficial muscles of the *Apteryx Australis*.

PLATE XI.

Fig. 1. Side view of the second layer of muscles of the *Apteryx Australis*.
2. *Plantar fascia*, or tendinal sheath formed by the expanded continuation of the tendon of the *gastrocnemius*.

PLATE XII.

Deep-seated muscles of the spine of the *Apteryx Australis*.

Fig. 1. The *sacro-lumbalis* (*l*) and *longissimus dorsi* (*m*) have been dissected off and reflected back, to expose the *spinalis dorsi* (*p*) and *multifidus spine* (*q*): and most of the insertions of the *longus colli posticus* (*o 1 to o 8*) have been detached and turned up, to show more clearly the *obliquus colli* (*m, m 1 to m 9*).
2. The *sacro-lumbalis*; its outer margin is raised, to show the *musculi accessorii* (*l 1 to l 5*).
3. The *obliquo-spinales* and the small deepest-seated muscles of the cervical vertebrae.

PLATE XIII.

Fig. 1. Muscles of the rudimental wing, and side view of the second layer of muscles of the neck.
2. Front view of the second layer of muscles of the neck.

PLATE XIV.

Front view of the muscles of the *Apteryx Australis*.

PLATE XV.

Fig. 1. Female organs of generation, *Apteryx Australis*;—natural size.
*a*. Rudimental right ovarium.
b. Full-developed left ovarium, with a yolk ripe for dehiscence.
c. Abdominal opening of the oviduct.
e. Probe introduced by the cloacal opening of the oviduct into the uterine or shell-secreting compartment.

Fig. 2 Slightly magnified view of the calciparous lining membrane of that compartment.
Femur of a Bird from New Zealand.