

## **Osteology of the Psittaci / by R.W. Shufeldt.**

### **Contributors**

Shufeldt, Robert W. 1850-1934.  
Royal College of Surgeons of England

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XVI. OSTEOLOGY OF THE PSITTACI.

BY

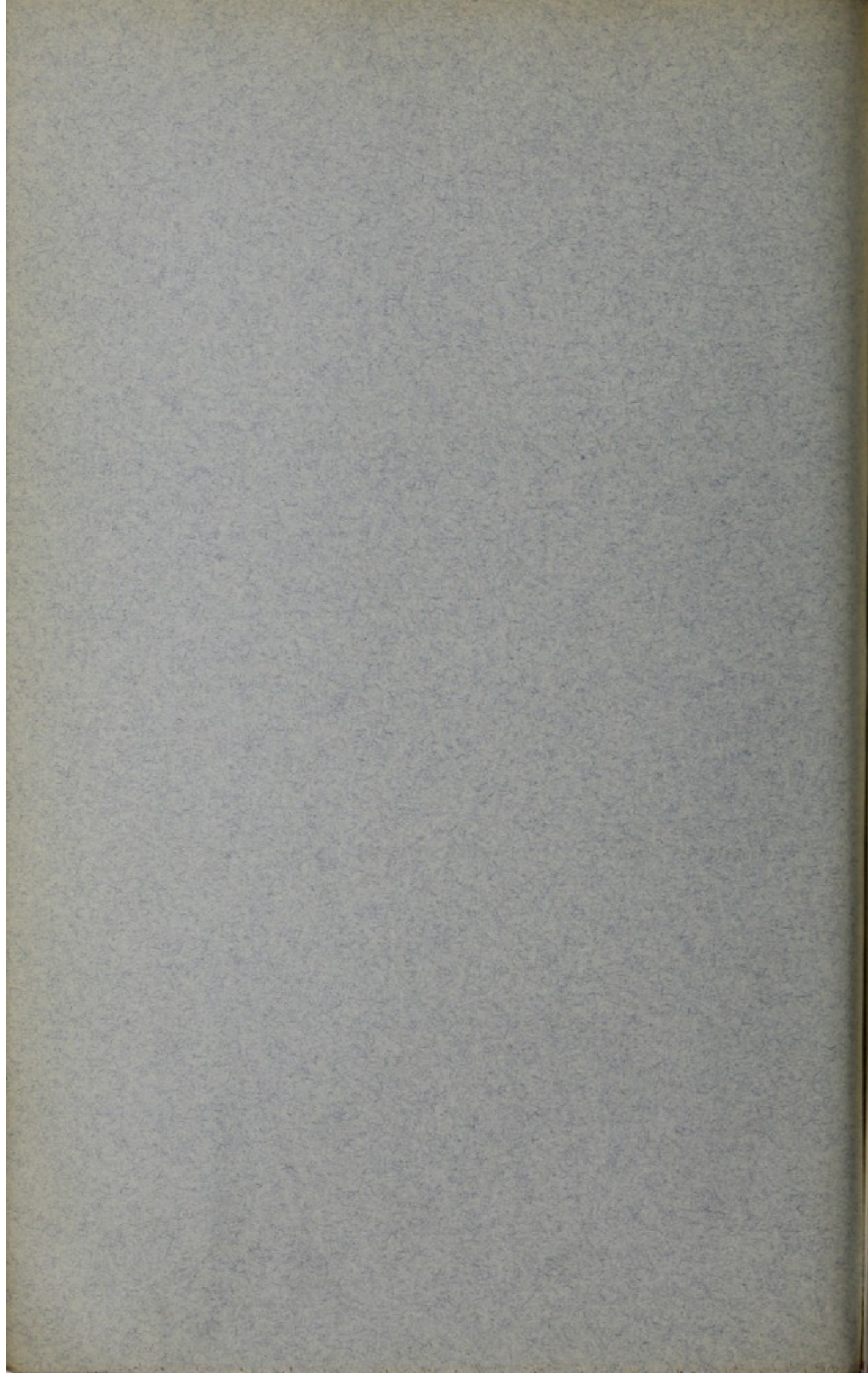
DR. R. W. SHUFELDT.



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## XVI. OSTEOLOGY OF THE PSITTACI.

BY DR. R. W. SHUFELDT.

In the Journal of Anatomy and Physiology of London for April, 1886 (Vol. XX, Part III, Art. No. IV, pls. X, XI, pp. 407-425). I published a very full account of the osteology of the Carolina Paroquet (*Conurus carolinensis*), it being illustrated by two lithographic plates including eighteen figures. Since then I have carefully revised this memoir and incorporated in it osteological notes I have made upon certain Cockatoos, Macaws and their allies, while to the contribution as a whole there has been added my review of the skeleton of a specimen of that remarkable bird known as the Owl Parrot (*Stringops*). The figures illustrating my original article upon the skeleton of *Conurus* were all from the specimen of a male bird, and those desiring to see the morphology of the bones of this paroquet illustrated in this way are referred to the Journal of Anatomy, *loc. cit.* Only the skull and trunk skeleton of a female individual are to be found on a plate in connection with the present memoir. There are here figured in the plates in addition, however, one or two interesting skulls, a trunk skeleton and other bones of other species of *Psittaci* that it is believed will be of value in illustrating the text.

Various classifications at different times have been proposed for this well circumscribed group of birds, including, as has just been said, the Parrots, Macaws, Paroquets, and their allies. In the best of these the *Psittacidae* have invariably been recognized as constituting a family easily to be characterized, and apparently one of marked naturalness.

The suborder is a comparatively large one, containing, according to recent authorities, somewhere in the neighborhood of 450 species. In the United States the *Psittacidae* are represented at the most but by two species. One of these, now upon the road to rapid extinction in this country, has already been mentioned, it being *Conurus carolinensis*, (Carolina Paroquet), found at the present time only in certain restricted areas in the Gulf States and the Lower Mississippi Valley. To this species, Ridgway also claims for our fauna the form known as

*Rhynchopsitta pachyrhyncha* (Thick-billed Parrot), as occurring in southwestern Texas and southern New Mexico.<sup>1</sup>

Avian taxonomers and ornithotomists still entertain considerable doubt as to the position of the *Psittaci* in the system, and much painstaking labor is yet required before we can gain any exact knowledge of their true affines. This applies also to the classification of the Parrots among themselves as an isolated group. Studies of the morphology of a great many of the species is what we stand particularly in need of; and this in some cases (*Strigops*) also demands to be supplemented by a research into their embryology.

Before presenting the osteological characters of *Comurus carolinensis* and other forms, we will submit here some of the opinions of leading ornithotomists having reference to the taxonomy of the *Psittaci* as a group, and of the probable relation of this group to others of the Class. Some of the earlier systematists, as Bonaparte and others, placed the *Psittaci* above all other birds, claiming for them the first place in the Class.

Professor Huxley created for them his *Psittacomorphæ* as one of the best defined groups of the order *Carinatae*. He has said of them that "all the Parrots present wonderfully uniform cranial characters" and that they "constitute one of the best defined groups of birds, having affinities, though of no very close character, with the Actomorphæ and the Coccygomorphæ."

In this morphological characterization of the *Psittacomorphæ*, he tersely presents us with some of the most striking anatomical peculiarities of Parrots, and these are sufficiently well known now to obviate the necessity of recapitulating them in the present connection.<sup>2</sup>

Ten years later Professor Parker said that "The desmognathous *Parrots* are very uniform, having the most complete cranio-facial cleft, with a perfect hinge-joint between the frontal and nasal regions.

<sup>1</sup>Ridgway, Robert. A Manual of North American Birds, 1887, p. 269. In this work it would seem that I am made responsible for this parrot having been observed in southern New Mexico. My knowledge of this rests upon the statement made to me by a captain of cavalry, U. S. Army, who commanded a scouting party in southwestern New Mexico in 1886 or 1887, who, when in camp just north of the Mexican line, noticed one morning "in the trees near his tent a flock of green parrots that had very large bills, and which were very noisy."

<sup>2</sup>Huxley, I. H. On the Classification of Birds; and on the Taxonomic Value of the Modifications of certain of the Cranial Bones observable in that Class. P. Z. S., London, 1867, pp. 415-472.



There is no vomer; the palatines are vertically elongated posteriorly, while anteriorly they are horizontally flattened, and movably united with the rostrum. The lachrymal and postorbital (or sphenotic) bend towards one another, and unite by the intervention of a large os uncinatum or antorbital. In some also the temporal fossa is bridged over by the union of the zygomatic process of the squamosal with the os uncinatum. The nasal septum is a thick wall of bone; an annular ossicle is found in the alinasal cartilage of *Melopsittacus undulatus*; in *Palæornis torquata* this part is largely ossified and anchylosed to the upper jaw, and the alinasal turbinal is partly calcified.<sup>3</sup>

Prior to this, however, that is in 1874, the late Professor Garrod had examined certain sets of anatomical characters in no less than 82 species of Parrots, and in that year he published in the Proceedings of the Zoölogical Society of London the results of his labors. Masterly as this work is, his classification of the *Psittaci* based upon it, is quite artificial, and hardly deserves adoption, except in a few of the points he makes. This is chiefly due to the fact that he ignored much of the osteology in the various species, and only paid attention to a few sets of morphological characters.<sup>4</sup>

Prof. Alfred Newton has expressed himself in the following words in reference to Garrod's labors upon the group of birds now under consideration, and as his views are quite in accord with my own in the premises, his remarks are here fully quoted; he says, "The principal points to which he attended were the arrangement of the carotid artery, and the presence or absence of an ambiens muscle, an oil-gland, and a furcula; but except as regards the last character he unfortunately almost wholly neglected the rest of the skeleton, looking upon such osteological features as the formation of an orbital ring and peculiarities of the atlas as 'of minor importance'—an estimate to which nearly every anatomist will demur; for, though undoubtedly the characters afforded by blood-vessels and muscles are useful in default of osteological characters, it is obvious that these last, drawn from the very framework of any vertebrate's structure, cannot be inferior in

<sup>3</sup> Parker, W. K., and Bettany, G. T. The Morphology of the Skull. London, 1877, p. 264.

<sup>4</sup> Garrod, Alfred Henry. On some Points in the Anatomy of the Parrots which bear on the Classification of the Suborder. P. Z. S., London, 1874, pp. 586-598. See also his Collected Scientific Papers, London, 1881, pp. 247-263, Plates VI and VII. It would be as well to add here that Prof. Garrod's successor, Mr. Forbes, had very little to say about the anatomy of the Psittaci.

value to the former. Indeed the investigations of Prof. A. Milne-Edwards (Ann. Sc. Nat. Zoologie, ser. S, vi, pp. 81-111; viii, pp. 145-156) on the bones of the head in various psittacine forms make it clear that these alone present features of much significance, and if his investigations had not been carried on for a special object, but had been extended to other parts of the skeleton, there is little doubt that they would have removed some of the greatest difficulties."

"The one osteological character to which Garrod trusted, namely, the condition of the furcula, cannot be said to contribute much towards a safe basis of classification. That it is wholly absent in some genera of Parrots had long been known, but its imperfect ossification, it appears, is not attended in some cases by any diminution of volant powers, which tends to show that it is an unimportant character, an inference confirmed by the fact that it is found wanting in genera placed geographically so far apart that the loss must have had in some of them an independent origin. Summarily expressed, Garrod's scheme was to divide the Parrots into two Families, *Palæornithidæ* and *Psittacidæ*, assigning to the former three Subfamilies, *Palæornithinæ*, *Cacatuinæ*, and *Stringopinæ*, and to the latter four, *Arinæ*, *Pyrrhurinæ*, *Platycercinæ*, and *Chrysotinæ*. That each of these sections, except the *Cacatuinæ*, is artificial any regard to osteology would show, and it would be useless here to further criticise his method, except to say that its greatest merit is that, as before mentioned (See *Encycl. Brit.*, Art. "Love-Bird," vol. XV, p. 28), he gave sufficient reasons for distinguishing between the genera *Agapornis* and *Psittacula*."

In the same place Prof. Newton further adds, that "Still more recently we have the arrangement followed by Mr. Sclater in the *List* of those exhibited of late years in the gardens of the Zoölogical Society, and published in 1883. This is more in accordance with the views that the present writer is inclined to hold, and these views may here, though with much diffidence, be stated. First there is *Strigops*, which must stand alone, unless *Geopsittacus* and *Pezoporus* may have to be placed with it in a Family *Strigopidæ*."

"Next *Nestor*, from its osteological peculiarities, seems to form a very separate type, and represents a second Family *Nestoridæ*. These two families being removed, all the Parrots that remain will be found to have a great resemblance among themselves, and perhaps it is impossible justifiably to establish any more families. For the present at



any rate it would seem advisable to keep them in a single Family *Psittacidae*, but there can be no objection to separating them into several subfamilies. The Cockatoos, for instance, can be without much difficulty defined, and may stand as *Cacatuinae*, and then the brush-tongued Lories as *Loriinae*, after which the Macaws, *Arinae*—including possibly *Conurus* and its allies."

"*Platycercus* and its neighbors may form another section, and the same with the *Palæornis*; but for the rest there is not yet material for arriving at any determination, though *Chrysotis* and *Psittacus* seem to furnish two different types, to the former of which *Psittacula* appears to bear much the same relation as *Agapornis* does to the latter. Amongst the genera *Chrysotis*, *Palæornis*, and *Psittacus* are probably to be found the most highly organized forms, and it is these birds in which the faculty of so-called 'speech' reaches its maximum development. But too much importance must not be assigned to that fact; since, while *Psittacus erithacus*—the well-known Grey Parrot with a red tail—is the most accomplished spokesman of the whole group, it is fairly approached by some species of *Chrysotis*—usually styled Amazons—and yet its congener *P. timneh* is not known to be at all loquacious."<sup>5</sup>

With respect to the relation of the *Psittaci* to the Raptorial Birds, Professor Newton has said, "That the *Striges* stand quite independently of the *Accipitres* as above limited can hardly be doubted, and, while the *Psittaci* or Parrots would on some grounds appear to be the nearest allies of the *Accipitres*, the nearest relations of the Owls must be looked for in the multifarious group *Picariæ*" (*loc. cit.*, Art. "Ornithology," p. 47).

In his invaluable and recent work "A Hand-List of the Genera and Species of Birds," Doctor R. Bowdler considers all the members of this group as forming an Order (XXVIII) — the PSITTACIFORMES — which he places between the STRIGIFORMES (Order XXVI [XXVII?]) and the CORACIFORMES (Order XXIX), the latter starting in with the family *Steatornithidae* without giving the actual number of the known species of this great host of birds as enumerated by this distinguished ornithologist. I would suppose that his scheme of classification for them is as follows:

<sup>5</sup>Newton, Alfred. Art. "Parrot," *Encycl. Brit.*, 9th ed., Vol. XVIII, p. 323 (1885).

Sharpe



ORDER.	FAMILIES.	SUBFAMILIES.	NO. OF GENERA.
PSITTAFORMES. (XXVIII.)	1. Nestoridae . . . . .		One.
	2. Loriidae . . . . .		Fourteen.
	3. Cyclopsittacidae . . . . .		Two.
	4. Cacatuidae. {	1. Cacatuinae . . . . .	Six.
		2. Calopsittacus . . . . .	One.
		1. Nasiterninae . . . . .	One.
		2. Coturninae . . . . .	Sixteen.
		3. Pioninae . . . . .	Ten.
	5. Psittacidae. {	4. Psittacinae . . . . .	Three
		5. Palæornithinae . . . . .	Seventeen.
		6. Platycercinae . . . . .	Eleven.
	6 Stringopidae . . . . .		One.

One more authority, and we proceed to set forth the osteological characters of *Conurus carolinensis*. Disregarding all other authors both early and late, and there are many of them, who have given to morphology no weight at all in their classifications, we must take into consideration the opinion of Fürbringer, as we have on so many previous occasions.

This authority arrays the Parrots as quite an isolated group in one of his intermediate suborders (Im. So.: Intermediäre Subordo), and of them he says: "Die artenreiche und in den Tropen weitverbreitete Familie der *Psittacidae* (p. 1285 f.) repräsentirt eine ziemlich hoch differenzirte und bei allem Artenreichthum enggeschlossene Abtheilung, die das Entwicklungsniveau der mittelhohen Baumvögel erreicht. Ihr morphologisches Verhalten und ihre Abgeschlossenheit allen anderen Vögeln gegenüber zeugt von hohem Alter, wenn auch die bisherige, noch ganz ungenügende palæontologische Kenntniss dafür kein directes Beweisstück ad oculos demonstrirte. Die *Psittacidae* bilden zugleich die einzigen Vertreter der G. PSITTACI und S. O. PSITTACIFORMES; diese Unterordnung dürfte aber wohl zwischen den Columbiformes, Galliformes und Coracornithes stehen, wobei sie vielleicht von den Erstgenannten am wenigsten entfernt ist. Die vereinzelt Ähnlichkeiten mit den Accipitres, welche manche Autoren veranlassten, nähere genealogische Beziehungen zu diesen anzunehmen möchte ich in der Hauptsache als Isomorphien beurtheilen. Übrigens wird es noch langer und mühevoller Arbeit und glücklicher Funde bedürfen, bis wir volle Sicherheit hinsichtlich der genaueren genealogischen Stellung der *Psittaci* erhalten."<sup>6</sup>

<sup>6</sup>Fürbringer, Max, "Untersuchungen zur Morphologie und Systematik der Vögel, etc." Amsterdam, 1888, p. 1552. The several plates illustrating this work may again be profitably examined in connection with the present Suborder, and it will be observed how thoroughly this author separates the Parrots from the *Accipitres*. It is upon this point that I differ with Professor Newton, and I am quite skeptical, as yet, as to there being any near affinity between the Diurnal Raptores and the *Psittaci*. - R. W. S.

THE CHARACTERS PRESENTED BY THE SKELETON IN *CONURUS*  
*CAROLINENSIS*.

From cranio-facial hinge to tip of beak the culmen of the superior mandible of the skull is much, though uniformly, arched. Posterior to the subcircular osseous nares this culminal surface is broad and nearly flat, but beyond these apertures it is convex, both transversely, and as has been said, along its middle line.

The dentary margins of this mandible are cultrate and deeply notched at their middle points, as shown in plate I, Fig 1, where the skull is shown upon right lateral view.

Complete fusion of the nasals, with the bones that surround them has taken place, and all the sutural traces have been absorbed.

The under side of this mandible is bounded behind by a straight, transverse line, above which the palatines are inserted. Its general surface, otherwise, is unbroken, and evenly concave throughout, save a faint medio-longitudinal ridge, best marked behind.

The interior of this superior mandible is, apart from the narial chambers, more or less filled up with an osseous, spongy tissue, that presents a more compact nature where it forms the anterior wall of these latter. This tissue has so far fused with the similar bony mass that represents the maxillo-palatines on either side, that one cannot with certainty judge of their exact limits or boundaries in this species of parrot. This condition also obtains in *Ara* and in *Cacatua* (see Figs. 1 and 3, Plate I).

Speaking in general terms, Professor Huxley says of the *Psittaci* that "the maxillo-palatines are very large and spongy in texture, and unite with one another and the ossified nasal septum so as to fill up almost the whole base of the beak. Above, however, a nasal passage is left on each side; and, below the maxillo-palatines stop short, so that, in the dry skull, a passage, leading into the cavity of the rostrum, is left on each side of the septum."<sup>1</sup>

These remarks are illustrated by the under view of the skull of *Cacatua galerita*, which bird, I think, from the drawing, must have its nasal septum, as well as the spongy mass which surrounds, produced a little further backwards than it is in the subject we have in hand and which is really the case in that species. However, the parts are homologous in both of these forms, though one would hardly have suspected the mass in question to have represented a part of the skull deserving of a special name, had the Carolina parrot been the only bird examined.

<sup>1</sup> Huxley, T. H., "On the Classification of Birds," P. Z. S., 1867, p. 442.



Among the points that have always attracted the most attention in the skeleton of the *Psittaci*, the cranio-facial hinge is here in *Conurus* as perfect in its mechanism as we perhaps will find it in any of the suborder.

Its structure is too well known to enter upon its details here ; I find, however, that neither in this parrot nor any other of the group that I have ever examined is this feature one whit better developed than it is in *Sula bassana*.

Passing now to other parts, we find the union between the sphenotic process and the descending portion of the lacrymal bone to be complete, forming an external orbital periphery or ring, which is very nearly circular (Plate I, Fig. 1). According to Parker, as I have already said, this is brought about through the intervention of the *os uncinatum*, which in some parrots, by union with the zygomatic process of the squamosal, bridges over the temporal fossa.

The lacrymal itself has indistinguishably, so far as a suture is concerned, merged above with the frontal bone, while its union with the sphenotic process, just alluded to, is equally well obliterated. Internally it unites in a similar manner with the small *pars plana*, a circular foramen for the olfactory nerve passing between it and the ethmoid, while externally the antero-inferior arc of the orbital ring is marked by a longitudinal concave notch.

As for the orbital cavity itself, its walls are but fairly entire, the *pars plana* being small, and the exit from the brain-case for the first nerve being far larger than this branch demands. Moreover, the palatines being vertical plates in this situation, and the pterygoids slender, the floor of the cavity is necessarily badly provided for in this regard.

In both these specimens the foramina for the exit of the optic and the third, fourth, and sixth nerves are distinct, and scarcely any greater in size than the structures they are designed to transmit are in calibre.

The interorbital septum is without vacuities, and merges directly throughout with the rostrum of the sphenoid beneath it, the lower margin of the whole plate being sharp, both inferiorly and in front.

Anteriorly the ethmoid bone proper is very broad, being spread out as an abutment against, and bordering for all its width, the posterior line of the cranio-facial hinge. The body of the bone is thickened and filled in with diploic tissue.

That portion of the skull which lies behind and below the orbital ring presents for examination, above, the lateral aspect of the evenly-

convex vault of the cranium, and below, the long squamosal process separated from the sphenotic by a well-defined valley.

The bony ear conch is circumscribed by rounded margins, while to its under side a sharp vertical plate is thrown down, the inferior rim of which is the continuation of the occipital ridge behind, as in *Ara* and *Cacatua*.

As is well known, the characteristic feature of a parrot's quadrate bone is, that its mandibular facet is single, and placed in such a way that its long axis is in the same straight line with the longitudinal axis of the pterygoid; to the possession of this narrow, convex, and long facet *Conurus* forms no exception. Above it, the body of the quadrate is flattened from side to side, with a conical projection on its outer aspect, posterior to its middle point, that has a pit at its apex to accommodate the apophysis on the inner side of the hinder extremity of the quadrate-jugal.

The orbital process of the quadrate is spiculiform and but moderately developed, while the mastoidal limb of the bone rises as a stout sub-cylindrical rod, with two convex articular facets at its summit. These are divided by a notch, and the inner one of the two is very small, not presenting more than one-tenth of the amount of articular surface the outer one does. The pneumatic foramen is found near its most usual place, on the inner and back part of the mastoidal shaft.

Viewing the skull now from above we observe that the narial apertures can also be seen upon this aspect surrounded above by a few minute vascular foramina, the former being comparatively unusually large in *Cacatua*.

The cranio-facial hinge bordering the superior mandible behind, is found to be a transverse and depressed line extending all the way across.

Between the superior orbital peripheries the frontal region of the skull is smooth and nearly flat; as we proceed backwards it gradually becomes convex, to form the beautiful rounded vault of the cranium. This flatness of the frontal region is very characteristic of the skull of *Ara militarius*.

A few perforating foramina are found just within the two edges of the orbits in the frontal bones, being situated posteriorly and above in the Cockatoos and Macaws.

Turning to the under side of the skull the most remarkable feature that confronts us is the extraordinarily fashioned palatines. These



bones, as they occur in the *Psittaci*, have been described by a number of anatomists, so their peculiar conformation is well known. *Conurus*, as in most true Parrots, has both of these bones horizontally flattened in front, where they are inserted above the hinder portion of the superior mandible to meet the lower part of the nasal septum, but not the palatine of the opposite side.

Proceeding backwards from this horizontal extremity, the palatine is seen to contract, then immediately afterwards to form a broad, oblong and vertical plate. This plate has a certain limited portion of its antero-superior part curled towards the median line, where it meets a corresponding edge of the fellow of the opposite side; and the two here form, by the assistance of the palato-ptyergoidal articulation, the usual longitudinal groove for the under edge of the rostrum.

Behind this, the superior margin of the palatine plate is sharp; the posterior margin shows a deep notch, while the inferior margin of the part of the bone is rounded, becoming in front continuous with the dilated anterior end.

Both the internal and external surfaces of these palatine plates may develop processes and ridges for the better insertion of muscles, which in life are thereto attached. A broad, spindle-shaped vacuity exists between these palatines in front, while posteriorly the angle separating their plates is somewhat less than the angle of divergence of the pterygoid bones.

These latter elements are long, nearly straight and cylindrical rods. They are at some distance below the basis cranii, and in no Parrot, so far as is at present known, do they develop basipterygoid processes. Anteriorly, their heads are but slightly enlarged to articulate with each other; with the lower rim of the rostrum; and with the palatines.

The maxillary portion of either of the infraorbital bars is inserted by a somewhat horizontally flattened end, just within the posterior edge of the beak, on a higher plane than the insertion of the palatines, and at a point where I take the foot of the nasal to be. The remainder of the bar almost immediately becomes of a uniform calibre, and at first being concave outwards, passes just beneath the orbital ring, directly downwards and backwards to its articulation with the quadrate.

At the cranial base we find a basitemporal area of small extent, triangular in outline, bounded on all its sides by raised lines, and having its apex directed anteriorly, terminating at the point where occurs the naked and external double-tubed entrance of the Eustachian canals.

On either side of these apertures are seen from three to four, or sometimes only two, minute foramina. Well to the outer sides of there are the conspicuous foramina ovalia.

As has already been said in a former paragraph, the temporal wings of the exoccipital are very prominently produced; and, as usual to their inner sides, at the basal angles of the basitemporal triangle are found the ordinary group of foramina for the entrance and exit of vessels and nerves.

The foramen magnum is of a subcircular outline, and the plane of its periphery makes an angle of some  $20^{\circ}$  with the backwardly-produced plane of the basis cranii. The condyle is comparatively large, hemispherical in form, and sessile. In *Ara* the foramen magnum is inclined to be cordate in outline.

Rising almost perpendicular to the basitemporal triangle, the occipital area is well defined by an elliptical bounding arc, which sweeps round on either hand to the apices of the temporal wings. In the middle of this space a moderately prominent, unpierced, supraoccipital elevation is to be seen. In removing the cranial vault I find that the tables are very closely juxta-opposed, and, in consequence, but a little diploic tissue present. The several cerebral fossæ are sharply defined by out-jutting lamelliform ledges of bone.

At the base of the sella turcica there seems to be a common carotid opening, and the posterior clinoid wall of this fossa is very thin, and usually exhibits one or two perforations.

The *mandible* (Plate I, Fig. 1) of *Conurus* is somewhat horseshoe-shaped, with very deep and smooth ramal sides, which are deficient anteriorly, leaving a semicircular opening with cutting edge all around. When the horny mandibular sheath is carefully removed in the fresh specimen, this edge has filiform prolongations of soft tissue standing out from its middle third below, which after they have dried and become more or less shrunken, look something like a row of delicate teeth.

The ramal sides of this bone slope away as we proceed backwards, and the mandibular ends are truncated at about the same angle.

To the inner sides of these articular ends a ledge is thrown out to support the facet for either quadrate. Behind these longitudinal articular grooves, single pits are found, at the base of which the pneumatic foramina occur.

The under borders of the mandible are smooth and rounded. The mandibles are very powerfully constructed in the Macaws and Cockatoos (See Figs. 3 and 4).



*Of the Hyoid Arches.*—Notwithstanding the fact that the glossohyal which supports the thick, short and fleshy tongue of this Parrot remains in cartilage throughout life, the ceratohyals are very completely developed. They meet in the median line, and ossify up to the very hinder body of this element and anterior to them. Where they unite at the mesial point behind, an articular surface is formed for the first basibranchial. This last named element is unusually long, and anchyloses with the second basibranchial, the point of mergence being enlarged to accommodate the heads of ceratobranchials and anteriorly to support a peculiar osseous outgrowth that, so far I am at present informed, is restricted to the *Psittaci*; indeed, this is the only form in which I have observed this latter feature.

The ceratobranchials are very long, subcylindrical and rather stout rods of bone, while, on the other hand, the epibranchials are notably short and but feebly developed. As thus constituted, the thyrohyal elements show but little curvature along their continuities, and still less disposition to curl up behind the cranium.

*Of the Remainder of the Axial Skeleton.*—*Conurus carolinensis* has thirty-five vertebræ in its spinal column, and a large pygostyle at its terminal extremity. This agrees with *Cacatua galerita*. (See Pl. III.) The *atlas* is characterized by a broad neural arch above, a perforated cup for the occipital condyle, and a prominent process extending backwards from the pseudo-centrum behind.

*Axis* vertebra has a very inconspicuous odontoid process, strongly developed neural and hypapophysial spines, and tuberos postzygapophyses. This segment, like the rest of the column and the pelvis, is pneumatic; to this statement, however, the last five caudal vertebræ and pygostyle prove an exception.

Both third and fourth vertebræ have strong hypapophysial spines, and neural ones scarcely less marked. In these, too, the lateral canals are seen, but the processes at their hinder margins are, as yet, but feebly produced. The zygapophysial arms are short, and their being joined from before backwards in each case by bone extension lend to these two segments a width upon their dorsal aspects and a solid appearance not possessed by any of the other vertebræ posterior to them.

In the fifth vertebra, the dorsal and ventral spines have lost not a little of their prominence, while the parapophyses are much longer. This segment has the postzygapophyses manifestly lengthened, whereas but little change has taken place in the anterior pair.

The sixth vertebra loses the neural and hypapophysial spines altogether; the parapophyses gradually diminish in size from this segment down the chain, until they, with the pleurapophyses, again become prominent as free ribs. Likewise the neural and lateral canals, which are here quite small, also increase in calibre as we proceed in the same direction. This vertebra has also a short carotid canal present in place of the hypapophysis. And this last feature is still better marked in the seventh vertebra, though it remains open below. These are the only two which have it in this parrot, in the eighth its site being again occupied by a low, median, hypapophysial spine.

In all these segments, as well as in the few succeeding ones that we find before coming to the true dorsals, the pre- and postzygapophyses are diverging limbs of the most usual form in *Aves*. The articulation among the centra is heterocœlous.

The ninth vertebra has the neural spine commencing to make its appearance again, and is here a low tubercle, more prominent in the tenth, and thus on till it assumes the dorsal form of this spine. The hypapophysial plates in both the ninth and tenth vertebræ are deep, long, and of a quadrate form, and from the lateral masses being low on the sides of the centra, they appear sunken between these protuberances.

We find that the twelfth vertebra has much the general aspect of one of the dorsals, and, moreover, its pleurapophyses have become freed as a tiny pair of ribs. These attain quite a respectable length in the thirteenth vertebræ, while in the fourteenth, where they are still unconnected with the sternum, they possess small unciform processes. This practically agrees with what we find in *Cacatua*. (Pl. II, Fig. 8.)

We may term the fifteenth to the eighteenth vertebræ inclusive true dorsals, for they all have ribs connecting them in the usual way with the sternum. They also have interlocking neural spines, and their transverse processes are strengthened by each one developing a single spiculiform interlacing metapophysis at its outer extremity. Prominent hypapophyses are found upon the thirteenth, fourteenth, fifteenth, and sixteenth, and a small one sometimes on the seventeenth vertebra.

The ribs have broad unciform processes ankylosed to them, but there are still two other pairs that come from beneath the pelvis, belonging as they do to the sacrum, that also meet costal ribs below, which do not have these appendages.

Sometimes abortive ribs are found ankylosed to the twenty-first and



twenty-second vertebræ, these being the third and fourth segments appropriated by the sacrum.

Now, in my male specimen of the paroquet, I find that the nineteenth to the twenty-ninth vertebræ, inclusive, form the pelvic sacrum, while in the female an additional segment, which in the male remains a free caudal, has become firmly attached behind.

This circumstance gives the male six free tail vertebræ, whereas the other specimen has but five. Such a condition as this, however, not unfrequently happens among birds, where the count for the entire number of vertebræ in the column remains wonderfully constant for the species.

The caudal vertebræ (Pl. I, Fig. 2) have spreading transverse processes, and stumpy neural spines; the ultimate two having strong bifid hypapophyses.

Of an irregular quadrilateral outline, the pygostyle has thickened hinder and lower margins, while the remaining two are cultrate.

Giving our attention now to the *pelvis*, we find this compound bone in *Conurus* (Pl. I, Fig. 2) devoid of any very striking features, it having all the general characteristics of this part of the avian skeleton, lacking anything to particularly distinguish it from the form the bone usually assumes among most ordinary birds.

Viewed from above, it will be seen that the pre- and postacetabular areas are about equal in extent, the ilium being concave where it forms the first, and the reverse where it constitutes the latter. For the entire length of the sacrum these bones are firmly sealed to its outer margins, forming the most complete "ilio-neural canals" anteriorly, which do not even open posteriorly as in some birds; while behind it lends to the postacetabular area a very unbroken aspect, that is rendered even more so from the absence of all but a few small foramina among the sacral diapophyses.

Upon the lateral aspect of the pelvis we note that the propubis is not developed, and that the inner periphery of the cotyloid ring is nearly as large as the outer one. The small obturator foramen is rendered complete by a pretty thorough meeting between the ischium and the somewhat slender postpubis immediately behind it.

The obturator space is long and spindle-shaped, but the lower angle of the ischium does not meet the postpubic shaft beneath it, as it does in so many birds.

The antitrochanter and the elliptical ischial foramen are both of comparatively moderate size.

On the under side we find that the lateral processes of the leading four sacral vertebræ are thrown out as abutments against the nether sides of the ilia ; beyond, or rather behind these, the usual cavity of the pelvic basin occurs, and the succeeding diapophyses of these consolidated vertebræ are less manifest than common, being all elevated and having their extremities in the roof above.

The foramina for the exit of the sacral nerves are double, in each case one being placed above another, and the swell to accommodate the myelonic enlargement in this part of the cord's track is here well pronounced.

*Conurus*, in common with many other parrots, has for its general size comparatively a large *sternum* (Plate I, Fig. 2). Seen from above we observe that the costal processes are but scarcely produced above the lateral borders, which latter rise gradually to their summits. These costal borders each support six facets for the hæmapophyses, the concavities among them being pierced by small groups of pneumatic foramina.

The space occupied by one of these costal borders is equal to about half the whole length of the lateral sternal margin. (Compare the sterna of *Cacatua* and *Calyptorhynchus* shown in Plate III, Fig. 8 and Plate II, Fig. 5.)

Posterior to them, on either side, the margins are sharp all the way round the xiphoidal extremity, this part of the bone having a shield-shaped outline, being concave above, though not nearly so much so as that part of the sternal body lying between the costal borders in front.

In this latter section we sometimes find a few scattered pneumatic foramina down the median line ; the most constant, and a large one of these, however, is close up to the anterior border of the bone, which curls backwards over it, and the fossa thus formed is always spanned over by a median longitudinal bridge of bone.

The anterior sternal body is thickened, and directly over its sharpened edge in front we find a continuous coracoidal groove ; beyond this there rears up directly a broad quadrate manubrium, which is continuous with, and has its lateral surfaces in the same plane with, the carina below.

Extending the entire length of the body of the bone the keel of this sternum is comparatively a very deep one. Both its lower and anterior borders are convex, the latter being quite sharp. The carinal angle formed by the meeting of these edges is rounded off, so that the lines form really one common curved line (Fig. 2).



That anterior vertical and thickened column of bone which is present in the keel of nearly all avian sterna is here well developed, but situated at some little distance back from the anterior margin. Moreover, it does not descend so far as is usually seen, being apparently interrupted by the muscular line which longitudinally marks the bone.

The muscular lines of the pectoral aspect are roughly parallel to the costal borders, and remain quite distinct as we proceed towards the xiphoidal extremity, nearly as far as the elliptical fenestra that there occur, one on either side.

In the *shoulder-girdle* (Fig. 2) we find a *scapula* with rather a short blade through a stout one, having the usual sabre-like form with obliquely truncated extremity posteriorly.

It contributes the usual amount of articular surface to the glenoid cavity, but when *in situ* does not occupy the entire length of the superior line of the scapular process of the coracoid, nor have any connection with the furculum except through a slight ligamentous attachment.

It will be observed that in *Conurus* the coracoid has a form that partakes much of the pattern it assumes among birds generally. (See Figs. 2, 5, and 8 of the plates.)

Its tuberosus summit is inclined slightly forwards and towards the median line, when articulated *in situ*, and has resting against it the frail clavicular head of that side. The scapular process already alluded to is well developed, but here chiefly given over to quite extensive ligamentous attachment.

The coracoidal shaft is strong, comparatively of good length, and subcompressed in the antero-posterior direction, being faintly marked at the usual sites by muscular lines.

At the sternal extremity of the bone we find the expanded portion, the form of which can best be seen in Fig. 2, where we note that the lateral process at its externo-inferior angle is well marked.

Many parrots are notorious for having incomplete furcula, as in *Calyptorhynchus*. (See Pl. II, Fig. 5). In others the union at their medio-inferior points is very feeble.

In this particular they resemble some of *Strigidae*. Our Carolina paroquet has a complete *os furculum*; it is, however, a very weak bone, and functionally accomplishes little more than an ossified ligament in the same position. Indeed, it reminds one very much of such a structure, for when duly articulated it is but little in advance of the imaginary plane that is tangent to the anterior surfaces of the coracoidal

shafts, and consequently but little dissociated from the ligaments that descend from the coracoidal summits to meet for attachment on the top of the sternal manubrium. It is in form of the U-shaped pattern, and without a hypocleidium at the clavicular junction below.

As already intimated above, and so far as the light I have on the subject will at present permit me to judge, I believe that the shoulder-girdle of *Conurus* more nearly resembles these parts in some of the owls than it does the corresponding lines in any other class of birds with which I am acquainted.

*Of the Appendicular Skeleton.*—The pectoral limb of this parrot presents no very striking deviations from the average skeleton of the wing as found in existing birds.

The bones are all harmoniously balanced both as regards their relative lengths and calibres.

Pneumaticity is enjoyed by the *humerus* alone, as in *Cacatua*, and this bone is here characterized by a short, though not inconspicuous, radial crest, an ulnar crest devoted, as usual, to forming a canopy over the pneumatic fossa, in which are found the air-holes leading to the interior of the humeral shaft. This latter is but little curved in any direction, being subcylindrical and smooth. At the distal extremity of the bone we find the trochleæ for articulation with the antibrachial elements prominently produced, while on the obverse aspect a broad and a narrow gutter is seen, which guide the passing tendons in life.

The *radius* is nearly straight for its entire length, differing from the *ulna* in this particular, it having a considerable curve along its shaft, the concavity of which is on the radial side, and gives rise to quite a wide interosseous space.

The carpal elements are two in number as usual, and they have the form most commonly presented by these bones throughout the majority of the Class.

In the manus we find a carpo-metacarpus of the ordinary form for birds generally. Its rather large pollex phalanx is without a claw, this feature being likewise absent from the tips of the distal digit.

None of the bones of the pelvic extremity in *Conurus* have air admitted to their interiors, and they all become dark and greasy in the ordinarily prepared skeleton. This is likewise the case in *Cacatua* and other *Psittaci*.

The *femur* has a large, semiglobular head, with a shallow, though



quite extensive excavation upon it, for the round ligament. A broad articular surface is found at the summit of the bone for the antitrochanter of the pelvis, and the suppressed trochanterian ridge does not rise above this.

The shaft of the bone is but little bent in any direction, and it has the usual cylindrical form. At the distal extremity the condyles are fairly well developed, not strikingly large, the outer one being the lower when the bone is held in the vertical position. In front the rotular channel does not extend upon the shaft above them, while behind the popliteal depression is shallow also.

The cleft for the fibular head marks the posterior aspect of the external condyle, dividing it, as usual, into two parts.

Our subject possesses a small *patella* of a subcordate form, maintaining its usual relations with the bones of the leg and thigh.

The *tibio-tarsus* has its cnemial crest but very slightly produced above the articulating surface at the summit of the bone, while below it the pro- and ectocnemial ridges are but feebly manifested, and very soon merge into the shaft. This latter is quite straight and smooth, being slightly compressed in the antero-posterior direction. At the distal extremity the inner condylar protuberance is decidedly the more prominent, both upon the front and rear aspects. The valley between these two eminences is quite wide and well defined, even to the posterior side of the bone.

The osseous bridge for the extensor tendons is present.

Marked feebleness in development is displayed on the part of the *fibula* of the Carolina Parrot, for this bone is found not to extend below the ridge it articulates with on the side of the shaft of the *tibio-tarsus*. Below this point the inferior apex of the fibular shaft is produced and replaced by a ligament of hair-like dimensions. In Cockatoos, too, the fibula is a very short bone. What there is of the bone in *Conurus*, however, is fully as well developed as we usually find it in the class; simply its apparently useless prolongation, as seen in many birds, has never ossified.

In the skeleton of the foot we find a short thick-set tarsometatarsus, with spreading trochlear extremity. Its shaft is short and straight, being much compressed from before backwards. On the anterior aspect it is convex from side to side, while behind it is longitudinally excavated. The hypotarsus is a narrow, projecting ledge with one vertical, cylindrical perforation near its center, and scarcely grooved

for the other tendons behind. At the summit of this bone we note the two condylar depressions for the trochleæ of the tibio-tarsus.

The usual arterial foramen pierces the shaft at its ordinary site at the distal end.

As is well known, *Psittaci* are permanently zygodactyle birds by reversion of the fourth toe, while they not only possess a well developed and free accessory metatarsal, but the usual number of joints to the digits. *Conurus carolinensis* agrees in all these particulars.

Whenever I can I make it a rule to fully illustrate in the figures the tibio-tarsus and skeleton of the pes, as the points presented by these parts stand among the most important in this all-important system of the bird's anatomy, for when sufficient data of this kind become available they will be not only valuable as an aid in classification, but help to determine the affinities of existing birds with such fossil forms as may from time to time be discovered. It will be seen that I have not overlooked this fact in the plates to my original memoir on the osteology of *Conurus*, published in the Journal of Anatomy of London.

#### SYNOPSIS OF THE SKELETAL CHARACTERS OF CONURUS CAROLINENSIS.

1. Superior mandible arched as in Raptores; osseous nares small, subcircular, separated by nasal septum. Dentary margins of mandible cultrate and notched.

2. Orbital ring complete.

3. Cranio-facial hinge as in other *Psittaci*.

4. Lower margin of rostrum cultrate.

5. Quadrate has a large and small facet on mastoidal head, a rather small orbital process, and a single, longitudinal mandibular facet, which is laterally compressed and convex in both directions.

6. Pterygoids long and slender rods, anteriorly articulating with each other and with the palatines.

7. Major portion of either palatine—a large vertical plate, directed downwards and backwards. These bones curl toward each other and form a limited articulation in the median line; anteriorly they are horizontally flattened, and are hinged to the mandible beneath the spongy mass, which constitutes the maxillo-palatine and nasal septum.

8. Mandible truncated in front; rami and symphysis deep and gradually rounding into each other.



9. Hyoid apparatus with large, united ceratohyals, and a peculiar bony outgrowth on either side of the first basibranchial, extending forwards.

10. Manubrium of sternum erect, large, and continuous with the deep carina. The xiphoidal extremity of this bone has an elliptical fenestra on either side. Costal processes low, and usually six hæmapophysial facets on each costal border. Coracoidal grooves unite in front.

11. Furculum of shoulder girdle firmly united below.

12. The humerus only is pneumatic in the pectoral limb.

13. A well-developed patella present. Fibula short, extending only so far as the lower end of fibular ridge of tibio-tarsus.

14. The tendinal bridge at antero-distal end of tibio-tarsus at right angles to long axis of shaft. The inner condyle the larger and more elevated.

15. General skeletal characters of pes agree with other *Psittaci*.

*Negative Characters.*

1. Vomer absent.

2. Basipterygoid processes not developed.

3. No hypocleidium on os furculum, and this bone does not meet the scapular process of coracoid.

4. Propubis of pelvis absent.

5. Pelvic limb non-pneumatic.

*The following osteological characters when associated in the same skeleton characterize a representative of the family PSITTACIDÆ of the suborder PSITTACI.*

1. Superior osseous mandible of skull with cultrate dentary margins, usually 1-notched on either side; arched as in *Raptores*. (The notching is absent in *Ara*.)

2. External orbital periphery usually completed in bone.

3. A movable cranio-facial hinge present in the skull.

4. A single mandibular facet on either quadrate.

5. The maxillo-palatines a spongy mass, fusing with the surrounding bones.

6. The rami of the mandible unusually deep, the symphysis truncated anteriorly.

7. Xiphoidal border of sternum rounded, unnotched; and may be pierced by a foramen on either side.

8. Os furculum concaved forwards as well as inwards; usually united, mesially, below, though the reverse may be the case.

9. Fibula markedly short.

10. Tarso-metatarsus short; the fourth toe permanently turned backwards, and articulating with a double facet.

*The Avian Affinities of the Psittaci.*

Not as yet positively known; most generally suspected of having kinship with the *Raptores*, and by Huxley, with his group the COCCYGOMORPHÆ, as well. Such speculation may be entirely erroneous, however, and after all the nearest kin to the *Psittaci* may be the Owls (*Striges*), a group having no specially close relationship with the *Raptores*.

OBSERVATIONS UPON THE OSTEOLOGY OF THE OWL PARROT.

(*Strigops habroptilus*.)

Various authors have given us brief accounts of the anatomical structure of this very remarkable family of the PSITTACI, but a complete account of its morphology is yet in demand. Several years ago, Professor Fürbringer considered it to be one of the primitive Parrot-forms (Journ. für Orn., 1889, pp. 239-241), and Garrod, Blanchard, and A. Milne-Edwards, have each and all contributed at different times something towards an understanding of its anatomy. Newton in his "Dictionary of Birds" under the article "Kakapo" gives an excellent brief article upon its history, and Sir W. Buller's "Birds of New Zealand," has a very considerable account of the same.

Newton remarks in the Dictionary that there "can be scarcely any doubt as the propriety of considering this genus the type of a separate family of *Psittaci*; but whether it stands alone, or some other forms (*Pezoporus* or *Geopsittacus*,<sup>8</sup> for example; which in coloration and habits present some curious analogies) should be placed with it, must await future determination."

Garrod has said,<sup>9</sup> "As a Parrot it is not so strikingly peculiar as many seem to think. Its wings are useless, and the carina sterni is correspondingly reduced, it is true; but as points of classificational importance, I regard these as insignificant. The points of special anatomical interest which it does possess, however, are particularly instructive.

<sup>8</sup> "Dr. Reichenow (Journ. für Orn., 1881, pp. 13-16) boldly unites them in a single family, but in that case it should bear the name of *Pezoporidæ*."

<sup>9</sup> Coll. Sci. Mem., p. 257.



"The proximal ends of the incomplete furculum are well-developed, so much so that it might at first sight seem that their symphysial ends are only lost in correlation with the excessive reduction of the powers of flight; though this is probably not the case, because the allied similarly modified genera *Euphema*, etc., do not keep to the ground."

Doctor Sclater and Dr. Sharpe have both in their schemes of avian classification placed *Strigops* in a family *Strigopidae*, and its structural peculiarities certainly entitle it to no higher rank in the system. *Geopsittacus*, externally, closely resembles the Owl Parrot, but I have not as yet had the opportunity to examine the osteology of this genus, and so from personal observations I am unable to say whether it ought to be included in the *Strigopidae* or not.

Apart from the partial atrophy of the pectoral limb, carina sterni, and possibly the os furculum, I see nothing very extraordinary in the skeleton of this Ground Parrot, as the balance of its osseous structure is completely psittacine, and points in no other direction whatever.

In the *skull* the orbital bony ring is complete, while the orbit, comparatively speaking, is rather small. The nostril is not circular as in *Conurus*, but presents a continuous limited concavity in front of it. For a Parrot the mandibles are lacking in the power so often seen in other members of the group. They are far *straighter*, and the notching at the end of the superior is barely evident.

As in *Conurus*, it has 14 *cervical vertebrae*, with a well-developed pair of free ribs attached to the last two. The *dorsals* include the 15th to 19th vertebrae and all these have ribs connecting with the sternum; and all these ribs have epipleural appendages save the last pair. This also applies to the only pair of *pelvic* ribs present, and these also connect with the sternum by means of their hæmapophyses. One pair of "floating ribs" are also present.

The *pelvis* in all essential respects is psittacine, and the *six* vertebrae of the tail, as well as the *pygostyle*, are well-developed.

While the skeletal frame of the wing is markedly reduced in size, this does not apply to the strong bony skeleton of the pelvic extremity, and both have the usual parrot-characters of these parts distinctly present. In the manus, both the *pollex* and the *index* digit are terminated by a minute, free claw-point, that is not to be found in all members of this suborder.

With this brief reference to the osteology of the famous Owl Parrot, I simply repeat here that I must believe there can no longer be any

question that this interesting form, simply represents a family, and probably a very old family of the psittacine group of birds.

#### EXPLANATION OF PLATES.

[The figures in Plates XXI-XXIII are all from photographs made by the author direct from the specimens, those of *Conurus* being in his own collection, and the others from specimens belonging to the United States National Museum. The skeleton of the Owl Parrot (*Strigops habroptilus* Gray) was photographed by Professor T. W. Smillie of the U. S. National Museum, and is specimen No. 18,276 of the osteological collections of that institution, it having been obtained at Dusky Sound, N. Zealand, a number of years ago.]

#### PLATE XXI.

Fig. 1. Right lateral view of the skull and mandible (the latter detached) of *Conurus carolinensis*. Adult ♀; natural size.

Fig. 2. Right lateral view of the trunk skeleton and attached shoulder girdle of *Conurus carolinensis*, adult ♀, natural size. From the same individual, the skull of which is shown in Fig. 1.

Fig. 3. Left lateral view of the skull and mandible of a Macaw (*Ara militarius*). Specimen collected by F. Bischoff at Mazatlan, Mexico.

#### PLATE XXII.

Fig. 4. Right lateral view of the skull and mandible (the latter detached) of *Cacatua galerita*, adult, nat. size. (Spec. No. 18,744.)

Fig. 5. Ventral aspect of the sternum and shoulder girdle of *Calyptorhynchus banksi*, adult ♀. (From N. S. Wales, Clarence River.)

Fig. 6. Anconal aspect of left humerus of *Cacatua galerita*. From the same individual which furnished the skull shown in Fig. 4, natural size.

Fig. 7. Palmar aspect of right humerus of *Cacatua galerita* from same specimen as Figs. 4 and 6. Nat. size.

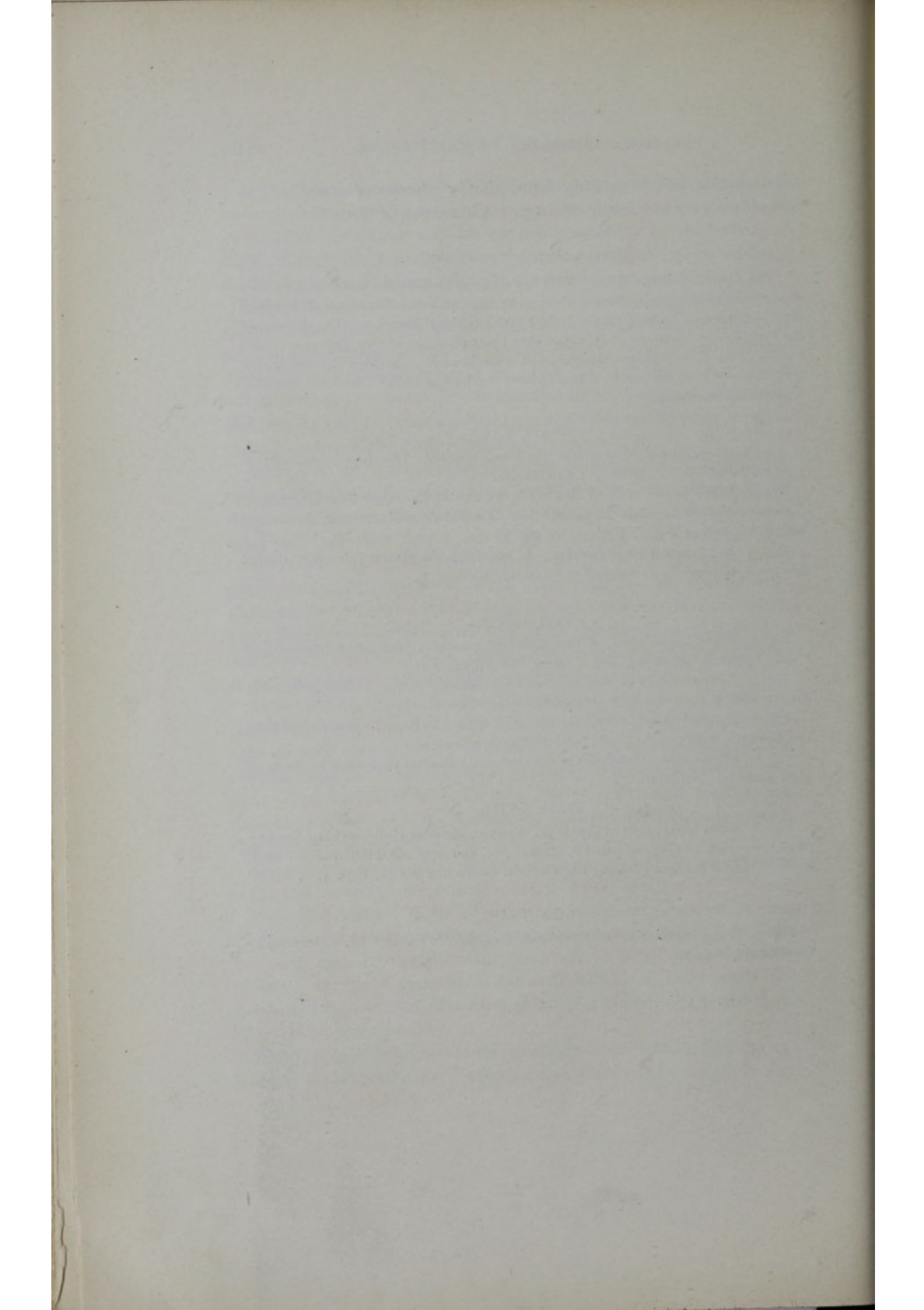
#### PLATE XXIII.

Fig. 8. Right lateral view of the trunk, skeleton, shoulder girdle, and last five (5) cervical vertebræ of *Cacatua galerita*, natural size, and from the skeleton of the same specimen which furnished the skull and humeri shown in Plate II, Figs. 4, 6, and 7.

#### PLATE XXIV.

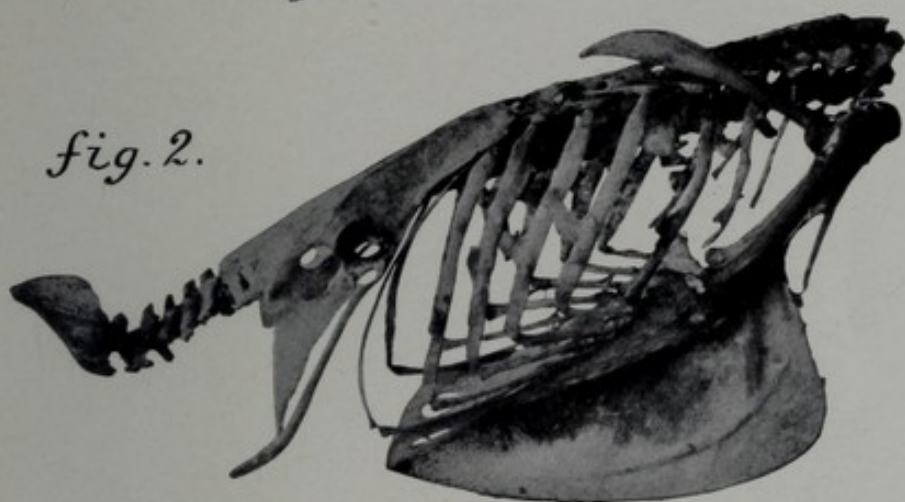
Fig. 9. Right lateral view of the skeleton of the Owl Parrot (*S. habroptilus*). Considerably reduced.







*fig. 1.*



*fig. 2.*



*fig. 3.*

Osteology of the Psittaci.



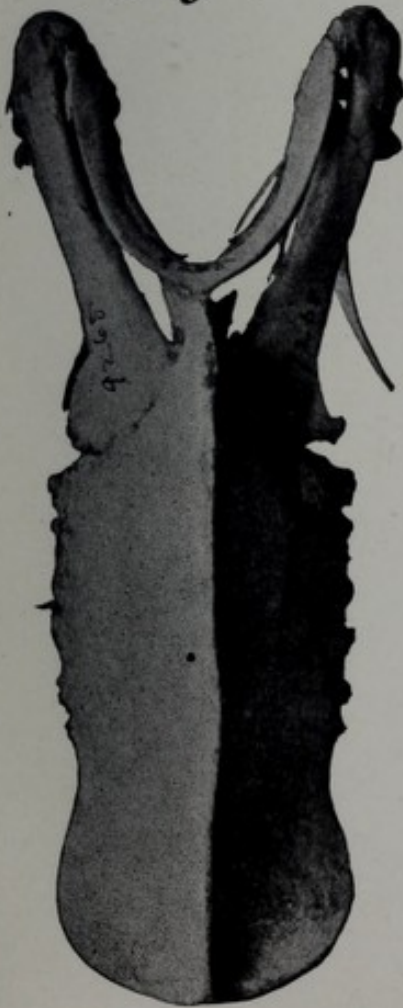




*fig. 4.*



*fig. 5.*



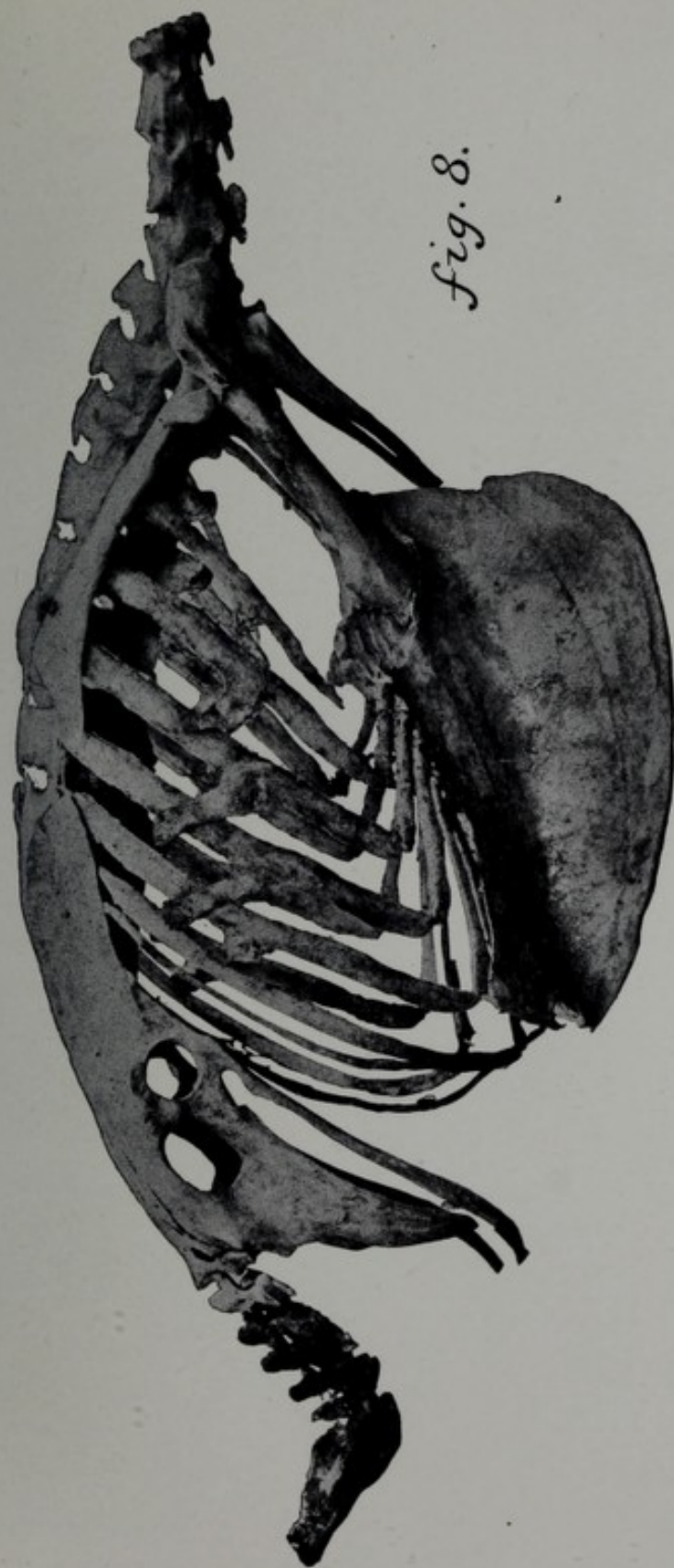
*fig. 6.*

*fig. 7.*





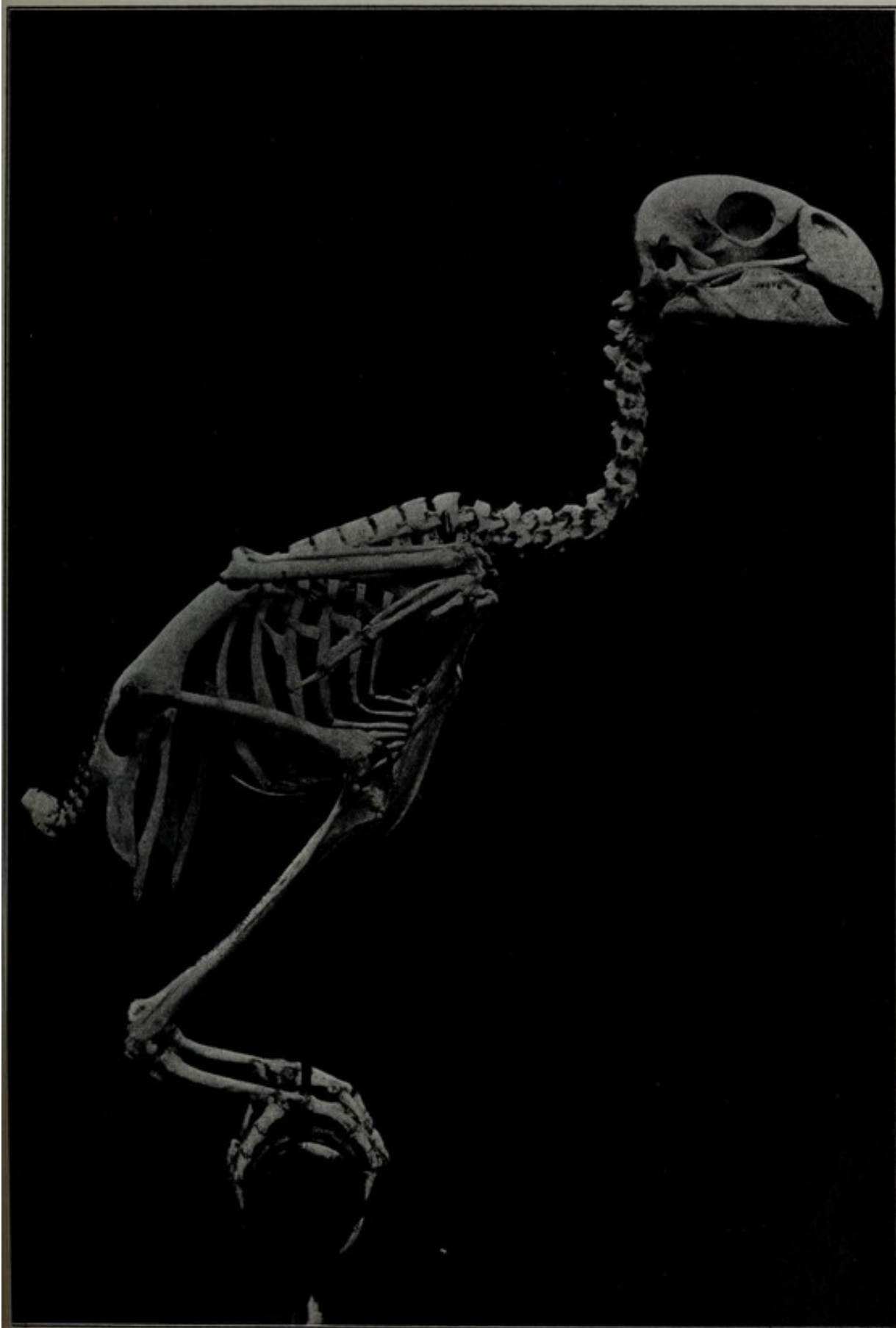




Osteology of the Psittaci.







Skeleton of Owl Parrot (*S. habroptilus*).



