

ON A COLLECTION OF BIRDS' STERNA AND SKULLS, COLLECTED
By DR. THOMAS H. STREETS, U. S. NAVY.

By DR. R. W. SHUFELDT, U. S. ARMY.

During the years 1884 and 1885, while attached to the U. S. S. "Patterson," and serving in the North and South Pacific, Dr. T. H. Streets, U. S. Navy, availed himself of the opportunity to collect a number of skulls and sterna from birds which he obtained at various localities visited by the "Patterson." These he has kindly forwarded to me for description and remark, and afterwards to make such disposition of them as I saw fit. In the subjoined table I give a list of these specimens, including the skull of a specimen of *Corvus corax sinuatus*, collected by me at Fort Wingate, N. Mex.

At the present writing the National Museum has in its possession the manuscript of a report by me illustrated by over 400 figures, the majority of which are devoted to the osteology of our arctic water birds; so when I came to look carefully over this material of Dr. Streets I found that I had already figured quite a number of them in my paper. In the present connection I will therefore present only such figures as will eventually prove additions to my far more extended labors in this direction.

As we would naturally suppose, and as will be seen in the accompanying table, the majority of the osteological specimens collected by Dr. Streets are from water fowl; those from the "Road-runner" and Raven forming the principal exceptions.

TABLE.

Specimens.	Collector.	Locality and date.	Remarks.
<i>Urinator lumne</i>	Dr. Thomas H. Streets.	Point Simpson, British Columbia, May, 1885.	Two skulls and two sterna, adults.
<i>Daption capensis</i>	do	Gulf Peñas, South Pacific, November, 1884.	Skull, sternum, &c., adult.
<i>Pelecanoides</i> sp. (?)	do	South Pacific, November, 1884.	Skull, sternum, &c.
<i>Cephus columba</i>	do	Southeast Alaska	Skull, sternum, &c., adult.
<i>Larus argentatus</i>	do	Off Lower California	Do.
<i>Larus californicus</i>	do	do	Two specimens, skull, sternum, &c., adults.
<i>Sula</i> sp. (?)	do	Off west coast of Mexico ..	Sternum and shoulder girdle.
<i>Chloephaga poliocephala</i>	do	Straits of Magellan, November, 1884.	Two skulls, ♂ and ♀, adults.
<i>Ardea herodias</i>	do	Southeast Alaska, July, 1885.	Skull, sternum, &c., adult.
<i>Nycticorax nycticorax naevius</i>	do	San Diego, Cal., February, 1885.	Do.
<i>Geococcyx californianus</i>	do	do	Do.
<i>Corvus corax sinuatus</i>	do	Southeast Alaska, August, 1885.	Skull, adult.
<i>Corvus corax sinuatus</i>	R. W. Shufeldt	Fort Wingate, N. Mex., December, 1885.	Skull, adult ♂.

This collection was originally presented by me to the Zoölogical Society of London, and my remarks about it were intended for their "Proceedings," but having learned from the society that they make no attempt to form a museum, the character of my contribution was very properly adjudged unsuitable, and I withdrew it.

It is with pleasure that I now present it, in our joint names, Dr. Streets' and mine, as a contribution to the anatomical collections of the U. S. National Museum, where in reality it more properly belongs.

In my remarks about them I will designate those by a (*) which I have figured in the manuscript referred to.

*Skulls of Urinator lumme.**—These specimens do not materially differ from others that I have examined coming from different parts of the world. They well illustrate, however, a point previously referred to by me in some other connection, which, for the moment, I do not recall, and that is, in comparing skulls of the same species in any series of vertebrates we are sure to meet with very interesting individual differences. Upon viewing these two skulls from above, we observe that in the larger one the supraorbital "glandular depressions" are much more sharply sculpt, while the bony ridge dividing them, in common with the median longitudinal ridge separating the crotaphyte fossæ behind, is sharp and thin, it being considerably broader in the smaller skull. Again, in the large skull the post-frontal processes project nearly directly outwards, while in the other specimen these apophyses are curved so as to point almost directly downwards. This difference can be better appreciated by viewing these two skulls from behind.

Regarding them upon lateral aspect, the chief feature to be noted is that both have a very large subcircular vacuity in the interorbital septum, and a fairly large one connecting the foramina for the exit of the second pair of cranial nerves. These two vacuities are in the larger skull well separated, while in the smaller specimen they all but merge into each other.

Viewed from behind, we find the condyle proportionately larger in the larger skull, and the skull of the smaller individual exhibits on either side of the "supraoccipital prominence" a small vascular foramen, with a vertical groove leading downwards and outwards from each, the prominence itself being perforated by a similar foramen in the median line. All of these apertures are absent in the skull of the larger bird.

Turning to the under side of these skulls we find but few decided differences worthy of comment. In each the *romer* is deeply carinated beneath, with a sharp spine terminating it in front, while in other particulars this element is very much as we find it in the *Larida*. The pterygoidal heads of the palatines behind curve outwards in either specimen, and those bones do not touch each other in the median line beneath the sphenoidal rostrum in this locality.

The sterna and girdles of these two specimens of *Urinator lunme** vary somewhat in size and pattern, but not sufficiently to demand any detailed description. In one the manubrium is fairly well pronounced, while in the other it may almost be said to be absent. A stumpy little hypocleidium is found on either furcula, and in one of the specimens this articulates with a well-developed facette found upon the anterior curved margin of the sternal keel. Both sterna have eight facets for the costal ribs upon either lateral border. Air does not gain access through pneumatic foramina to either the sternum nor into the bones composing the shoulder girdle in this diver.

On the skull, shoulder girdle, and sternum of *Daption capensis*.—It will be seen from the list of material that he examined that Forbes has already investigated the skeleton of *Daption*, although he says very little about the skull of this bird in his admirable paper on the Petrels.† In form and general appearance, however, it very closely resembles this part of skeleton in *Æstrelata lessoni*, the skull of which bird he figures in three positions in the memoir just alluded to (Pl. IV, figs. 1, 2, and 3). Rodger's Fulmar has a very similar shaped skull, and I have nearly the entire skeleton of this bird figured in the above-mentioned osteological memoir.

Daption possesses the characteristically broad vomer found in both *Æstrelata* and *Fulmarus*, and in it, too, we find the basiptyergoidal processes well developed. The postero-external angles of the palatines are always rounded off in all three of these genera, while the anterior extremities of these bones curve outwards as they merge with the premaxillary and maxillo-palatine on either side.

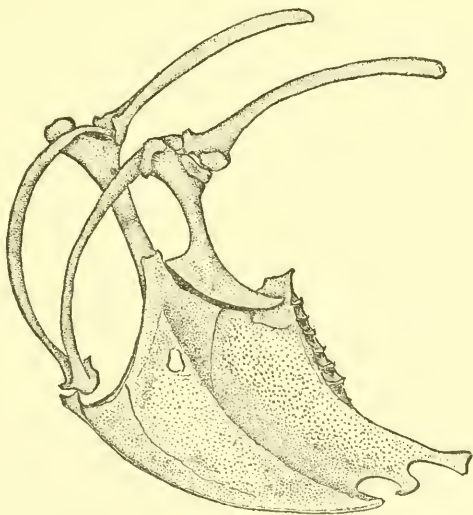
We find the symphysis of the mandible in *Daption* to be very short, and the side of the ramus of this bone at the junction of its middle and posterior thirds is more than double as deep as it is in any other part of its continuity. Viewed from above it is of a typically V-shaped outline.

Forbes in his figure (Col. Sci. Mem., Pl. XXIV, fig. 2) of the hinder extremity of the sternum of *Daption capensis*, draws but one rounded "notch" in it for either side of the keel, while in the specimen before me, collected by Dr. Streets, there are on either side of the carina two very complete and rounded notches, as may be seen in my drawing of this bone herewith presented.

My studies in another connection of the sterna of other birds more or less nearly related to *Daption* compel me to believe that a still larger series of this bone from individuals of the form now under our consideration will eventually show that the xiphoidal extremity of the body of its sternum is doubly notched on either side of the carina, and that in some way or another Mr. Forbes has presented us with an incorrect drawing of this part of the sternum of *Daption*, or else his specimen came from an immature or perhaps injured bird.

† Zoöl. Chall. Exp., Vol. IV, Pt. XI, p. 3.

For the rest, the outline of the "sternal body" of the bone in question is oblong, though but slightly longer than it is wide. There are six hæmapophysial facets for the sternal ribs on either costal border, but there are no pneumatic foramina in the concavities between any of them, nor does air gain access to the sternum of this bird at any other part of it. The manubrial process is but slightly developed, while quite a prominent projection curves upwards from the intersection of the anterior and inferior borders of the carina. The lower mid-point of the furcula rests upon the superior surface of this projection. I find the keel of this bone perforated near its anterior part, and the line of junction with the sternal body; this latter feature is a common characteristic of the sterna of certain other arctic waterfowl, as the Jægers, for instance.



1. Antero-oblique view of the sternum of *Daption capensis*, with the shoulder girdle *in situ*. Drawn by the author from a specimen collected by Dr. Streets, of the U. S. Navy, in the South Pacific. Life size.

Turning to the shoulder girdle, we find the blade of a *scapula* to be narrow and of nearly an equal width throughout, while at the same time it is gently curved for its entire length in the vertical plane. The head of this bone is proportionately quite massive, and articulates with a long, transverse, linear facet on the back of the corresponding coracoid. A *coracoid* is shaped very much as we find it in *Fulmarus* and some of the Albatrosses, where it is chiefly noted for the extraordinary width of its expanded sternal extremity. (Fig. 1.)

The head of the bone is tuberos, being directed forwards, and inwards towards the median plane. A small foramen perforates the shaft of the bone in an antero-posterior direction near its middle. Both coracoids show this perforation, and it is held in common with related types.

The *furcula* is U-shaped, with its clavicular limbs rather delicately proportioned. Its coracoidal ends are produced in tapering points,

which points fail to quite meet in this specimen the scapulæ behind them. Below we find the hypocleidial enlargement to be carinated posteriorly, while it is extensively scooped out in front. As already stated, this part of the bone rests, when the girdle is naturally articulated, upon the upper side of the projection found at the antero-inferior angle of the sternal keel.

The skull, sternum, and shoulder girdle of Pelecanoïdes (sp. ?).—When Dr. Streets collected this interesting specimen he was uncertain of the species and took the pains to write out a description of its external characters and coloration before taking its skull, &c. Mr. Ridgway, who kindly undertook to diagnose the bird from this, could not be quite positive as to the species, although he seemed to think that there was no doubt whatever as to its being a *Pelecanoïdes*. I also forwarded the original description of Dr. Streets to my friend Mr. J. A. Allen, who at the present writing still has it in his possession, and I have not heard from him on the subject; in a previous letter he very kindly reminded me of the several species of this genus that were to be found in the South Pacific. My own isolated position from all the literature of such subjects prevents me from investigating the point personally, though I doubt very much that I could have done more than Mr. Allen and Mr. Ridgway have already so kindly attempted in the case.

Comparing the front and side views of the sternum of the specimen with the drawing of the same views and bone made by Forbes (Coll. Sci. Mem., Pl. XXI, figs. 3 and 4) of the sternum of *Pelecanoïdes urinatrix*, I find them to agree in all particulars, and it is just possible that our specimen came from an individual of that species.†

In quite a number of its characters the skull resembles the skull of *Daption*, though it is but little more than half the size. The external osseous nares are somewhat differently shaped, and are not well defined, elongated and longitudinal elliptical openings as they are in *Daption*, but have their anterior margins indefinitely defined, from the fact that the bone on either side of the line of the culmen is here depressed nearly as far forwards as the tip of the beak. This lends to the premaxilla a crest-like appearance along in this region, and gives it a prominence not possessed by either *Daption* or *Fulmarus*. The supra-orbital glandular depressions are separated in the median line by a very

† Since writing the above I have had a letter from Mr. Allen, in which he says that he believes the specimen to have been a *P. urinatrix*.

The following is Dr. Streets' original description of the bird: "Total length, 8 inches. Head and bill, 50^{mm}. Bill along culmen, 15^{mm}. Tibia, naked, 5^{mm}. Tarsus and middle toe, including claw, 54^{mm}. Middle toe and claw, 32^{mm}. Tarsus, 22^{mm}. Wings, 6.50 inches. Spread of wings, 15.25 inches. Tail, 2 inches.

"Bill black, except a narrow rim along the lower edge of lower mandible, which is bluish; naked part of tibia, tarsus, and feet light blue (lavender). Claws black. Under parts of body white. Mantle black, with a bronze luster in the light. Under surface of web of feet black, and a black spot on the tarsus behind, near its articulation with tibia. Tail nearly square, slightly rounded. Wings not folded beyond tail; second primary scarcely longer than the first, which is longer than the third."

thin crest of bone for a considerable distance, while in *Daption* these depressions do not meet here by several millimeters. Moreover, we notice behind in one skull of *Pelecanoïdes* that the eotaphyte fossæ are very deeply depressed, and are bounded posteriorly by a thin, raised, almost knife-edged crest of bone; no such feature marks the skull of *Daption*. Viewed from beneath, we find the basiptyergoidal processes developed in one specimen, while the heads of the pterygoids themselves, opposite these projections, are much expanded in the horizontal plane, being compressed in these parts from above downwards. The "postero-external angles" of the palatines are rounded off, and the hinder moieties of these bones are in contact for a considerable distance beneath the rostrum of the sphenoid. Anteriorly, the palatines are carried directly forwards, and these extremities do not curve outwards, as I described them above for *Daption*. The *romer* of this specimen is proportionately narrower than the corresponding bone is found to be among the Fulmars, though it possesses much the same shape.

In the condition of its interorbital septum; the form of its lacrymal bone; the position and proportions of its *pars plana*; and the style of its quadrate, this skull of *Pelecanoïdes* almost exactly agrees, except in point of size, with the corresponding features in the skull of *Daption*. It also possesses the same peculiar pattern of a post-frontal process, which forms a prominent wing-like projection, standing out from the side of the skull, a character well drawn for us by Forbes in his figure of the skull of *Æstralata lessoni*, alluded to above.

As the sternum and shoulder girdle of this bird agree so closely with both the description and figures given by Forbes for *P. urinatrix*, it will obviate the necessity of my saying anything further about them here.

The skull, sternum, and shoulder girdle* of Cephus columba.*—The skull of this species was not in my possession at the time I completed my memoir on the arctic water birds, but a figure of its superior aspect has been given us by Sir Richard Owen in his memoir upon the osteology of the Great Auk, and the form is so well known generally that I can dismiss it in a few words. There is a great deal about it to remind us of the skull as we find it among the *Laridæ*, and, indeed, in many particulars it comes nearer the skull of a true *Larus*, as, for instance, *L. californicus*, than does such a form as *Larus philadelphia*. Its mandibles, however, are gradually tapered out to a point, whereas in the Gulls, as we know, the superior mandible is gently decurved at the tip. The characters presented us upon the under side of the skull in this Guillemot are almost exactly, practically exactly, as we find them in the typical Gulls. The relations of these groups I have elsewhere attempted to define, in so far as their osteology seems to indicate them.

The skull sternum* and shoulder girdle* of Larus argentatus.*—I find no special differences among these bones and the corresponding specimens belonging to the National Museum, which I have already

described and figured. They are all very perfect and complete, and show every evidence of having been prepared with great care. I notice at the infero-external angle of the *pars plana* and lacrymal of this Gull a small flake-like ossicle, freely articulated and directed backwards. This little bone is found on both sides, but is absent in the two skulls of *L. californicus*.

My MSS. not being at hand, I am unable to say whether I found any such character present in the Alaskan specimens I examined and figured or not.

It does not agree either in position or character with the "ossiculum lacrymo-palatinum" as found among the Albatrosses—the "os crochu" of Reinhardt.

The sternum of this Gull is highly pneumatic, and possesses six hæmapophysial facets on either costal border. On the other hand, the bones composing the pectoral arch are completely non-pneumatic and correspondingly heavy. I have fully described these parts elsewhere.

The skull, sternum, and shoulder girdle of Larus californicus.—One of these skulls is rather larger than the other, though the individual characters differ but slightly between them, and nothing like as much as we found to be the case in the two skulls of the Red-throated Divers, described above. *Larus californicus* has a skeleton almost exactly like *L. argentatus*, except that it is about one-third smaller. It consequently demands no particular description in the present connection.

The sternum and shoulder girdle of Sula (sp.?).—The manuscript to which I have already referred also contains a full account of the skeleton of *Sula bassana*, thoroughly illustrated by life-size drawings of the various bones of the skeleton. The specimen before me, however, does not agree with the corresponding parts of that Gannet, and I am strongly inclined to believe that it comes from some other species of the genus, but neither the literature nor the proper material is at present at my hand to enable me to express a trustworthy opinion in the case. This sternum and girdle have the general pattern, however, of the bones as we find them in *S. bassana*, where not only the former bone but all of the elements of the pectoral arch are highly pneumatic.

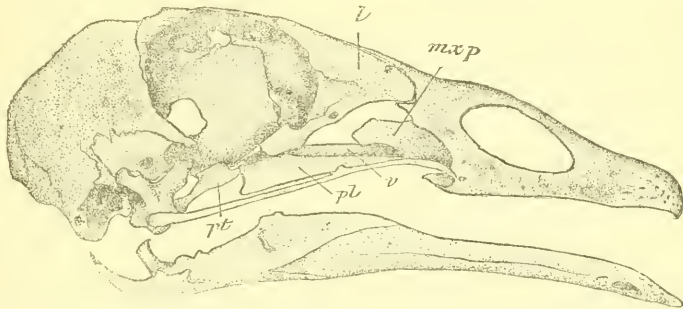
I find in the specimen before me five facets for the hæmapophyses on either costal border, while the xiphoidal extremity shows a deep and rounded notch on either side of the carina, and so fashioned that the lateral processes formed by them are far more prominent than the mid-projection standing between them; or, in other words, these "notches" merge into each other in the middle line, forming as they do so an inconspicuous mid-process. The sternal keel is lost upon the under side of the body of this bone at some distance before it reaches the posterior margin, while anteriorly it projects forward in a very prominent manner, where the lower mid-enlargement of the furcula articulates with it, but does not anchylos, as it is said to do in *Tachypates*. Each cora-

coidal head of the furcula develops on its outer side a massive enlargement supporting an elliptical facet directed backwards for articulation with a similar facet on the front part of the head of the corresponding coracoid.

A coracoid is peculiar in having the outer moiety of its expanded sternal extremity not adapted to the sternum by articulating in a groove.

The mesial moieties of these parts of the coracoids are very amply provided for, however, in this particular, and rest in extensive articular excavations intended for them. The sternum is without a manubrium, and the coracoidal grooves do not meet in the middle line.

The skull of Chloephaga poliocephala.—Under the article "Goose," in the ninth edition of the Encyclopædia Britannica, Prof. Alfred Newton tells us that "The southern portions of the New World are inhabited by about half a dozen species of geese, * * * separated as the genus *Chloephaga*. The most noticeable of these are the Rock or Kelp



2. Right lateral view of the skull of *Chloephaga poliocephala* ♂. Drawn life-size by the author from a specimen collected in the Straits of Magellan by Thos. H. Streets, U. S. Navy. *l*, lacrimal; *mxp*, maxillo-palatine; *v*, vomer; *pl*, palatine; *pt*, pterygoid.

Goose, *C. antarctica*, and the Upland Goose, *C. magellanica*. In both of these the sexes are totally unlike in color, the male being nearly white while the female is of a mottled brown, but in others a greater similarity obtains."

This is all the literature that I have at hand at the present writing in regard to these birds, and although I am familiar with *C. magellanica*, I do not recall the species *C. poliocephala*, unless indeed it be another name for the same Goose.

In general form these skulls differ considerably from the skulls of our *Bernicla* or *Branta*, as they are now known, and rather seem to slightly approach the skulls of some of the Ducks in certain characteristics.

Viewed from above, we find the supra-orbital glandular depressions unusually well marked for an anserine bird, and they are separated in the median line by about 3^{mm}; being rather more than this in the female specimen.

A lacrymal bone has, in each instance, almost completely ankylosed with the frontal and nasal of the same side; and at the lower extremity of this bone we find an ossicle similar in every respect with the one I described above as occurring in the skull of *Larus argentatus*. This little bone shows well in the figure, extending backwards from the lower expanded portion of the lacrymal.

Both of these skulls have a foramen on either side of the supra-occipital prominence, the pair being much larger in the large skull than they are in the other. I have elsewhere pointed out that these apertures may exist as extensive vacuities, or be altogether absent in the same species of Duck or Goose.

They constitute by no means a constant character for the same species of any of the group, so far as my observations go; and, indeed, in the same skull the foramen may be present on one side and absent on the other.

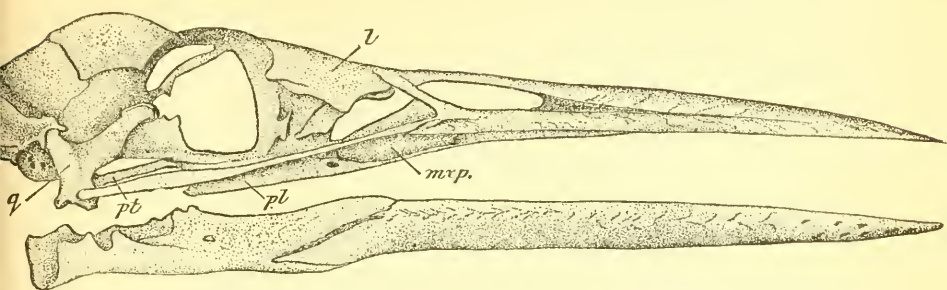
The pterygoids and the basipterygoidal facets are here, as we find them among the anserine birds generally, and the articulation of the heads of the former with the proximal ends of the palatines are the same.

As in the members of its group, too, we find the *vomer* to be an oblong lamina of bone placed vertically, with its forward projecting spine, from the antero-superior angle, resting on the osseous median mass representing the fused maxillo palatine elements in front of it.

The skull, sternum,* and shoulder girdle* of Ardea herodias.*—Upon comparing these specimens with the corresponding parts of the skeleton, taken from Blue Herons that I have collected in different localities throughout the United States. I find little or no difference worthy of mention existing among them. Length of mandibles is apt to vary a little, but I take it that this is due to the age of the specimen.

The skull, sternum, and shoulder girate of Nycticorax nycticorax nevius.—A skeleton of this Heron was not at hand at the time I completed my work upon the osteology of birds &c., but from an examination of the skeleton of *Nycticorax violaceus* I was rather inclined to believe that we would be enabled to pick out certain characters that would distinguish the diurnal from the more typical Night Herons. Upon making a critical comparison, however, between the skull, sternum, and shoulder girdle of this Black-crowned Night Heron and the same parts before us in *A. herodias*, I fail to find any definite characters to satisfactorily distinguish them by, except their difference in size. Indeed, the skull of the Black-crowned Night Heron agrees, in all essential details with the skull as we find it in the Great Blue Heron, except, as I say, it is about one-fifth less in point of size. No, if we are to look to the morphology of the Herons for characters to differentiate the two American genera, *Ardea* and *Nycticorax*, we, I feel sure, will have to resort to an examina-

tion of their entire structure, when possibly we may discover some reliable differences between them.



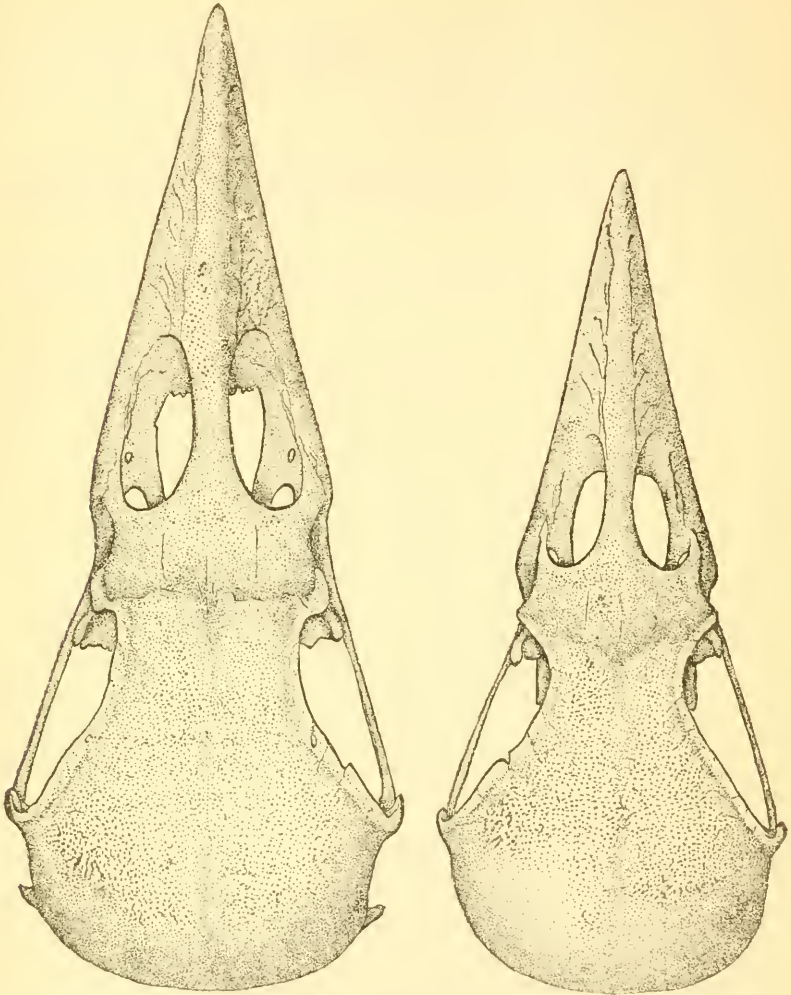
3. Right lateral view of the skull of *Nycticorax nycticorax naevius*. Life-size, adult ♂; drawn by the author from a specimen collected by Dr. Streets at San Diego, California. *q*, quadrate; *l*, lacrymal; *mzp*, maxillo-palatine; *pl*, palatine; *pt*, pterygoid.

The skull, sternum, and shoulder girdle of Geococcyx californianus.—I have already published a detailed account of the skeleton† of this exceedingly interesting form, and have had the opportunity to examine a number of their skeletons. My type skeleton I presented to the museum of the University of Cambridge, where, through the kindness of Prof. Alfred Newton, it has been mounted for the collection. The specimens before me, collected by Dr. Streets, do not differ in any of their important details from the corresponding parts of the skeletons of the others that I have examined. I find, however, that the delicate *vomer* usually present in the skull of this Ground Cuckoo is missing in the specimen before me, and probably has been lost. Col. James Stevenson, of the U. S. National Museum, who has recently been in Southern California, tells me that he saw upon two occasions the ranchmen of that part of the country chase one of these birds on horseback for a distance of a mile or more at full speed, when the cuckoo, being in the lead, would suddenly stop and fly up among the upper limbs of some stunted tree or bush at the roadside, and the rider, who has kept it in view all the time, dismounts and easily takes the exhausted bird from its perch alive. A specimen I dissected about a year ago I am told was captured in that way.

The skulls, sterna,* and shoulder girdles* of Corvus corax sinuatus.*—For more than two years past I have collected specimens of Ravens about Fort Wingate, N. Mex., here, and prepared skeletons of them; I have also fully figured this part of their anatomy in all its details, and had come to believe that the skeletons of my specimens differed in no way from those of other birds of this species from any other part of the United States. But upon receiving Dr. Streets' collection I found

† Shufeldt, R. W. *The Skeleton in Geococcyx*: Jour. of Anat. and Phys., London and Edinburgh, Vol. XX, Pt. II, Jan., 1886, pp. 244-266, Plates VII, VIII, and IX.

in it a skull, sternum, and shoulder girdle which had been taken from a true Raven fully one-fifth or more larger than those I found about Fort Wingate.



4. The superior aspect of the skull of a specimen of *Corvus corax sinuatus*, collected by Dr. Streets in S. E. Alaska; adult.

5. Same view of the skull of a specimen of this species collected by the writer at Fort Wingate, New Mexico; adult. Designed to show the difference in size between the northern and southern races of the American Raven. Both figures life-size and drawn by the author.

These skulls differ somewhat in detail, too, and some of the differences, as well as the discrepancy in point of size may be appreciated by examining the figures (Figs. 4 and 5) of the skulls of these birds which I present with this paper. Probably no better example than this, illustrating, as it does, a fact long well known to us, could be

offered, and that is, there are a great many species of North American birds which gradually increase in size as we pass from the southern parts of the country in a northward direction. And here we have it very prettily exemplified in the skulls of the Ravens, for one specimen comes from the southern limit of the United States and the other, and at the same time the larger one, comes from the extreme northern country—that is, from Alaska.

FORT WINGATE, NEW MEXICO, *March*, 1887.