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On the Comparative Osteology of Orthorhamphus magnirostris (the Long-billed Stone-Plover).

BY DR. R. W. SHUFELDT, F.A.O.U., Hon. Member R.A.O.U., C.M.Z.S., &c., WASHINGTON, D.C.

THIS great Plover-like bird is known in Australia as the Long-billed Stone-Curlew, being carried on the Check-list of the Royal Australasian Ornithologists' Union as *Esacus magnirostris*, where its range is stated to be "North-Western Australia, Northern Territory, and North Queensland." It is further known to occur, according to Sharpe ("Hand-list of Birds," vol. i., p. 173), in the "Bismarck Archipelago, and north to Borneo and islands of Bay of Bengal." This author, in the work cited, recognizes seven sub-orders as composing his Order (XV.) CHARADRIIFORMES, a group containing all the true limicoline birds, with a number of their congeners, as the *Otididæ* and others.

Sub-order VI. is created to contain the *Œdicnemi*, or the Thick-kneed Plovers, which are arrayed under four genera—namely, *Œdicnemus*, *Burhinus*, *Esacus*, and *Orthorhamphus*. Of all these, only two species occur on the Australian continent, and these are *Burhinus grallarius* and the subject of the present paper. In the R.A.O.U. "Check-list," the former species is listed as *Œdicnemus grallarius*, and is known as the Southern Stone-Curlew.*

The principal writers on the birds so far mentioned have been Linnæus, Temminck (the genus *Œdicnemus*), Illiger (the genus *Burhinus*), Lesson (the genus *Esacus*), Salvadori (the genus *Orthorhamphus*), and some twelve other ornithologists who have described species included in these four genera. Sharpe includes them all in the family *Œdicnemidæ*, which is doubtless quite a natural group.

As belonging in this group, Lydekker describes the extinct fossil form *Milnea gracilis*, from the Lower Miocene of France

* Gould, "Birds of Australia," vi., Plate V.; Handbook, ii., p. 210. Plate VI. of this work is devoted to *Orthorhamphus magnirostris*, but it is, in my judgment, not a particularly good figure, and I have compared it with a number of fine skins of the species in the collection of the U.S. National Museum. These were placed before me by Mr. J. H. Riley, of the Division of Birds of that institution, to whom I am likewise indebted for favours in connection with attending to my needs with respect to the skeletons selected for comparison.

("Cat. Foss. Birds," p. 169, 1891), based on material which I have not had the opportunity to examine.

The genera *Burhinus*, *Esacus*, and *Orthorhamphus* contain only a single species each, while in *Œdicnemus* about ten are recognized, and these occur in nearly all parts of the world with the exception of North America.

So far as I am aware, there has been no detailed description published of the osteology of *Orthorhamphus magnirostris*, and certainly not one in which its skeleton is compared with skeletons of its relatives, either near or remote. There is a very perfect skeleton of this bird in the collection of the United States National Museum, apparently from an adult male (No. 19,649), and I am indebted to Dr. Charles W. Richmond, Assistant Curator of the Division of Birds of that institution, for the loan of it for the purposes of study and description. In this connection Dr. Richmond also placed at my disposal a large number of skeletons of other species of birds, with which the osteology of *Orthorhamphus* should be compared. Such a comparison seemed to be desirable, and, having been undertaken by me, it is now set forth in the present article, which I trust will be found useful to students of the osteology of birds.

The Skull.—This part of the skeleton of the form here being considered is of unusual interest on account of the characters it exhibits being found in the skulls of various birds which represent entirely different families.

Viewed upon superior aspect, and starting at the superior margin of the occipital area, it is to be observed that the *crotaphyte fossæ* are deep and broad. Their mesial ends, which are rounded, do not meet in the middle line by at least five millimeters. Either depression, when followed toward the side, increases in width, extending finally from beneath the post-frontal process to include the entire superior margin of the boundary of the osseous meatus. These crotaphyte fossæ are very characteristic, and differ in the skulls of representatives of various species and groups of birds. *Œdicnemus bistriatus* probably has them formed in the same way, as a mutilated skull at hand so indicates (No. 90,996, Coll. U.S. National Museum), while in more or less typical Plovers these depressions are very shallow, and restricted to a limited area at the sides of the cranium. (*Squatarola squatarola*, 19,015, Coll. U.S. Nat. Mus.; *Belonopterus chilensis*, 18,546, Coll. U.S. Nat. Mus.; and many others.) *

* Shufeldt, R. W., "Observations upon the Osteology of *Podasocys montanus*," Journ. Anat. and Phys., Lond., Oct., 1883, v., 18, Part I., pp. 86–102 (see figs. 1–4 of the plates). Garrod, Alfred Henry, "On the Value in Classification of a Peculiarity in the Anterior Margin of the Nasal Bones in Certain Birds," P.Z.S., 1873, pp. 33–38. Also Coll. Sci. Papers, p. 124, figs. 1–11. The figures illustrate superior views of the skulls of *Alca impennis*, *Larus argentatus*, *Numenius arquatus*, *Columba livia*, *Parra* (*Hydralector*) *cristata*, *Arctica alle*, *Pedionomus torquatus*, *Otis tarda*, *Gallus domesticus*, *Daption capensis*, and *Coccothraustes vulgaris*, which are here arrayed in the order in which Garrod numbered them in his paper. Although illustrating another osteological point, they are very useful as showing the

The point here to be noticed, however, is that they are, among others, deep in *Larus* and other Gulls, and in probably other typical longipennine birds, in all of which they approach each other mesially, having but a small interval between them, while in *Chiornis*, Plovers, and the Oyster-catchers (*Hæmatopus*) they are restricted in area and situated laterally.

Passing forwards to the parietal region or vault of the cranium, it is to be noticed in *Orthorhamphus* that there is here a rounded, median, longitudinal groove, extending from the supra-orbital glandular depressions backward to a level area, just beyond the interval between the crotaphyte fossæ. This groove is practically what is found, too, in the *Laridæ* and others, while it is almost entirely absent in *Chiornis*, *Hæmatopus*, and others, and quite so in most Plovers. In these latter birds there are no "parietal eminences," which are well marked in *Orthorhamphus*, *Larus*, and in some other Gulls, but not in all, as they are absent in *Rissa*, a species in which only the lateral boundaries of the aforesaid median groove are elevated.

From the parietal region forwards, to include the remainder of this aspect of the skull, the characters vary in no small degree throughout all of these genera of birds. In *Orthorhamphus* the vaults of the orbital cavities are considerably raised above the mesio-frontal area of the skull, and, omitting either lacrymal bone, the free margin of each is notably sharp, and continues to be so to the very apex of the post-frontal process. The orbital roof on either side is perforated by a few scattered and minute foramina, and these are far less evident in *Œdicnemus*, while in *Squatarola squatarola* they are confined to a circular foramen of some size, on either side, being situated well within the orbital margin just beyond the parietal region of the cranium. In most Gulls these foramina again are small and scattered, while in *Chiornis* and the Oyster-catchers they are arranged in a row upon either side and well within the orbital margin. As I have elsewhere shown, they vary considerably throughout the *Limicolæ*.*

In the mesial area of the frontal region of the skull of our subject, on this its dorsal aspect, there is to be seen the very con-

character of the "crotaphyte fossæ" in the skull figured. It will be observed that these concavities are nearly absent in *Gallus*, *Coccothraustes*, *Columba*, *Parra*, and *Pedionomus*, while they are separated by a large interval in *Numenius* and *Otis tarda*, coming more or less closer together in *Larus*, in the Great Auk, and in *Daption*.

* Shufeldt, R. W., "Osteology of *Numenius longirostris*, with Notes upon the Skeletons of Other American *Limicolæ*," Journ. Anat. and Phys., Lond., Oct., 1884, pp. 57–82, Plates IV., V. (see Plate V., fig. 1*b*). This paper describes and compares the characters of a number of limicoline birds, which descriptions will repay examination in connection with what is set forth in the present contribution.

Coues, Elliott, "Birds of the North-West," Govt. Printing Office, Washington, D.C., 1874, pp. 592–602. We have here a brief, though good, account of the osteology of the *Laridæ*, wherein the superior frontal regions of the skull in several genera of the *Longipennes* are compared, and the facts noted may, with advantage, be taken into consideration with the present study of the skull of *Orthorhamphus*.

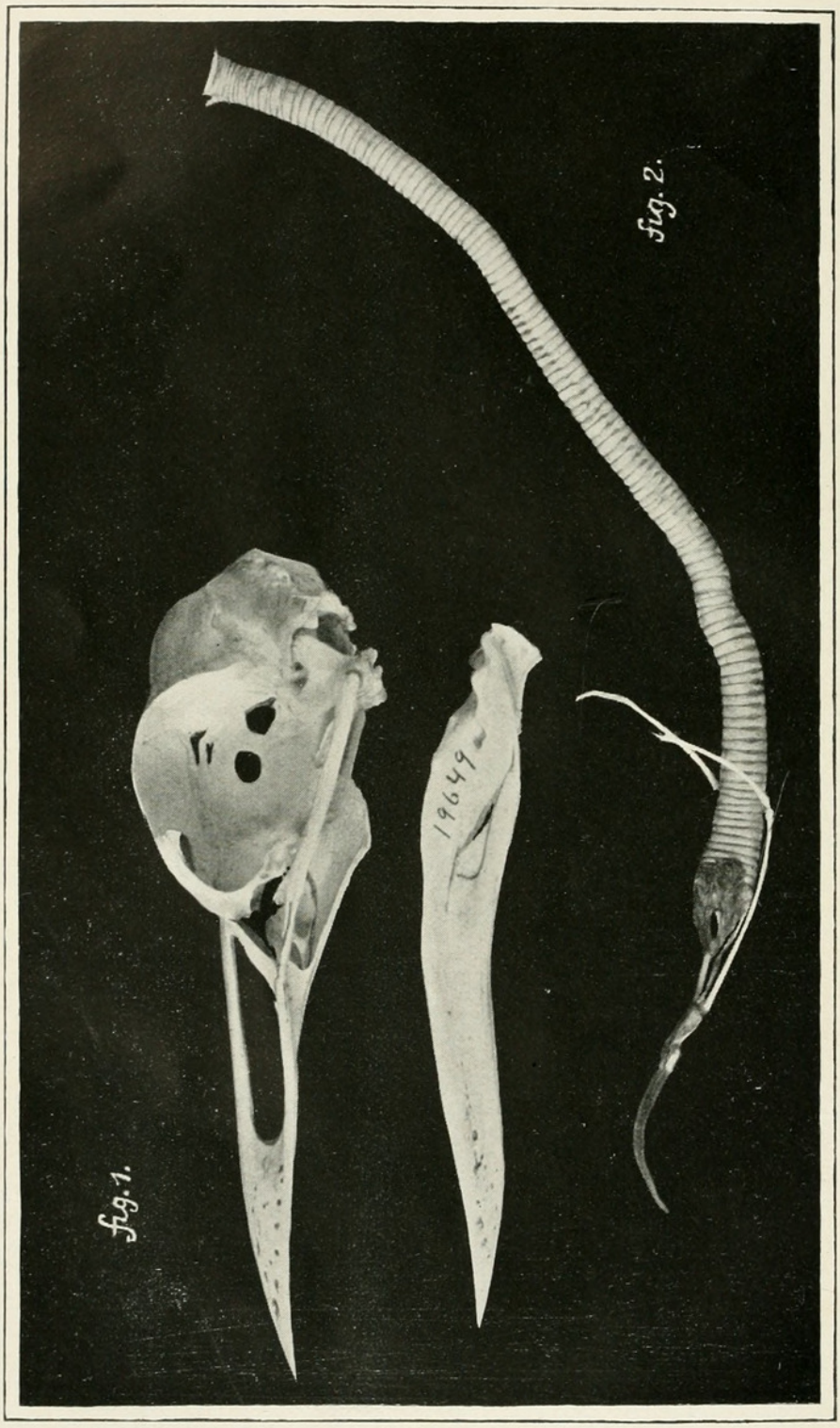
spicuous *supra-orbital glandular depressions* ; they are quite unlike those concavities as they occur in the skulls of any of the birds before me at this writing, and, moreover, they differ widely from what we find in *Œdicnemus*, in which latter form they are shallow, well separated in the median line, curve outwards anteriorly, and, finally, each depression terminates near the fronto-lacrymal suture, on its own side, in a foramen of no great size.

Now, in *Orthorhamphus magnirostris* these depressions meet for their entire lengths in the middle ; they are unusually deep, being rounded posteriorly and truncated in front, each terminating anteriorly in a large, single elliptical foramen, situated between the frontal and lacrymal bones. These are well shown in fig. 7 of Plate II., and it is to be observed that, laterally, these concavities are far removed from the orbital margins, which is also the case in the skull of *Œdicnemus bistriatus*. In some true Plovers, however, as is the case in *Squatarola*, these glandular depressions are very shallow ; they meet mesially in the frontal region, each to curve outwards behind, in which locality alone they do not approach the orbital margins. Here the lacrymo-frontal foramina are mere notches, while, as already remarked above, a pair of foramina are found over the middle of the orbits, one upon either side. (Compare figs. 16 and 18 of Plate VI.)

In the Chilean Lapwing Plover (*Belonopterus chilensis*, fig. 15, Plate VII.), the character of these depressions is again entirely different. Each consists of a distinctly defined, long, and narrow concavity, with a single small foramen at the extreme anterior end. A considerable interval separates them in the median line, and each is very slightly curved, the concavity of which is toward the sharp, free margin of the orbit. They are almost identical in their morphology in the Kittiwake Gull (*Rissa t. tridactyla*) and in the Black Oyster-catcher (*Hæmatopus niger*), where they are more or less shallow, meet in the middle line, extend to the free peripheries of the orbits, and to the external apices of the lacrymals. In *Rissa* they do not extend very far posteriorly, while in the Oyster-catcher they are continued on either side to the tip of the post-frontal process. We find their characters the same in *Larus glaucus* and other Gulls, while in *Larus argentatus* they are separated in the middle line (No. 18,204, Coll. U.S. Nat. Mus.) *Œdicnemus bistriatus* has them short and broad, separated mesially ; and a single foramen is situated far forwards in each of these shallow cavities (fig. 18, Plate VII.) They are entirely different in *Chionarchus minor*, as is shown in fig. 14 of Plate VII., and, as I have elsewhere shown, they depart in their characters in this bird from any other form ever examined by me in the entire Class *Aves*.*

* Shufeldt, R. W., "Contributions to the Comparative Osteology of Arctic and Sub-Arctic Water-Birds," Part I., Journ. Anat. and Phys., Lond., Oct., 1888, vol. xxiii. ; n.s., vol. iii., pp. 1–39, Plates I.–IV., 40 figures. Many of the skulls here figured should be compared with the skull of *Orthorhamphus magnirostris*. These "Contributions" ran through in nine parts (Oct., 1888–91), and contain many descriptions and figures of skeletons of

PLATE II.



If one will compare fig. 7 of Plate II. of the present article with figs. 14 to 19 inclusive of Plate VI., it will readily be appreciated that the *lacrymal bones* are morphologically very different in all of the skulls of the birds so far noticed.

Either *lacrymal* in *Orthorhamphus magnirostris* does not appear to fuse or anchylose with any of the bones surrounding it with which it articulates. Mesially, it forms in this species the antero-external periphery of the large, ellipsoidal foramen, at the distal termination of the supraoccipital glandular depression, while its postero-external angle juts out beyond the superior free margin of the orbit. It is convex on its dorsal or superior surface, and correspondingly concave below, where it forms a part of the roof of the orbit in front. Its descending process is first directed inwards, then outwards, to terminate in a triangular, expanded free extremity that barely clears the infra-orbital bar. The middle part is slender and directed posteriorly, and it is there we find the pneumatic foramen entering on its anterior aspect (fig. 1, Plate II.) Anteriorly, it makes an extensive and close articulation with the nasal bone of the same side.

A lacrymal bone in *Œdicnemus bistriatus* essentially agrees in form with that element of the skull as I have just described it for *Orthorhamphus*, while in other particulars it is quite different; for, in the first place, it is stouter; it fuses with all the bones it comes in contact with, the sutures being practically obliterated; and, finally, it may or may not form part of the periphery of the small foramen in the concavity for the supra-orbital gland.

Belonopterus chilensis possesses lacrymal bones much as we find them in *Œdicnemus bistriatus*, with the exception that the descending portion of either one of them is far more slender, and may be in contact with the outer margin of the pars plana. Moreover, it does not reach down so far toward the zygoma, and midway on its anterior border it develops the fine little spicula of bone, pointing forwards, which is found in the same locality in various other true Plovers. This little spine is well shown in Professor Huxley's figure of the side view of the skull of *Charadrius pluvialis*, cited above. (Fig. 7.)

birds that would repay comparison with the skeleton of the subject of the present paper. (Part IX. gives a full account of the skeleton of *Chiornis minor*.)

Shufeldt, R. W., "On the Affinities of *Aphriza virgata*," Journ. Morph., Boston, Nov., 1888, vol. ii., No. 2, pp. 311–340, Plate XXV. Gives figures of the bones of the skeleton of this bird, which has some affinities with the Plovers.

Huxley, Thos. 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., Lond., 1867, pp. 415–472, Figs. 1–36. Parts of the text and several of the figures refer to Plovers and Gulls, which may be of advantage by way of comparison in the present connection. Professor Huxley evidently had before him a skull of *Charadrius pluvialis*, in which the foramen at the anterior end of the supra-occipital glandular depression of the right side was incomplete, its periphery on the outer side being non-continuous; this having been caused by its encroachment upon the margin of the orbit. The foramen on the left side is entire (figs. 7 and 8).

Oyster-catchers (*Hæmatopus*) have their lacrymal bones very much as they are in certain *Laridæ*, though their upper portions project more prominently, and the descending limb of either of these bones is much stouter, making a more extensive union with the side of the pars plana. As viewed from above, this agreement is well shown in figs. 17 and 19 of Plate VII. of the present paper, and there, too, will be seen, on the same aspect, the lacrymals in *Chionarchus*, *Squatarola*, and others, each and all of which I have described in former osteological papers.

One of the most interesting features of the skull in these big, Plover-like birds is the *superior mandible* (fig. 1, Plate II.; figs. 5 and 6, Plate III.; fig. 18, Plate VII.) Measuring along the culmen, from the cranio-facial hinge to the apex, in *Orthorhamphus*, it is seen to have a length of 7 centimeters, whereas this same length in *Œdicnemus bistriatus* measures but 5.3 centimeters. In both skulls the narial apertures are large and elongo-elliptical in outline, while both differ from all the true Plovers, Gulls, Oyster-catchers, and numerous other limicoline and larine species in being *holorhinal birds*, and not schizorhinal ones. The holorhinal conformation of the nasal bones, in the case of *Œdicnemus*, has long been known, and on that account probably suspected in the case of *Orthorhamphus*, though the fact has not heretofore been published.*

In *Orthorhamphus*, the superior mandible is not only of large size, very long and tapering, but it is likewise somewhat decurved, with rounded culmen and cultrate tomia. Most Plovers, on the other hand, have the upper mandible and the dentary portion of the jaw nearly straight, with the narial openings extended to within a short distance of the apex in the upper bill. This is the case with a good many of the *Limicolæ*.

Turning to the basi-cranial region of the skull of the bird here being considered, it is at once apparent that in all of its general characters it far more closely resembles the corresponding part of the cranium in an average Gull—*Larus argentatus*, for example —than that of any Plover that I have ever examined or compared it with. Indeed, all this part of the cranium in *Orthorhamphus* is almost typically larine in its morphology.

Most all Plovers (*Squatarola*, &c.) have present the "supra-occipital foramina," one on either side of the supra-occipital prominence. These are small in the Chilean Lapwing, but of good size in the Golden Plover and others. In *Orthorhamphus* they are entirely absent.

* Forbes, W. A., "Coll. Sci. Mem.," pp. 189–213, figs. 1 and 2. This talented avian anatomist, who died at Shonga, Africa, many years ago (1st January, 1883), here says that "Birds belonging to the *schizorhinal* group are nearly all, with the exception of *Platalea* and *Ibis*, '*schizognathous*,' as regards their palate. The '*Schizorhinæ*' comprise the following minor groups:—*Columbidæ*, *Pterochlidæ*, *Turnicidæ*, *Parridæ*, *Limicolæ* (except *Œdicnemus*, which is holorhinal, herein agreeing with the Bustards), *Laridæ*, *Gruidæ*, *Eurypygidæ*, *Rhinochetidæ*, *Plataleidæ* (the *Hemiglottides* of Nitzsch), and *Alcidæ*." He also pointed out that *Mesites* and all the *Rallidæ* are *holorhinal* birds.

Anteriorly, the very spacious auricular cavity is better protected by a thin, osseous wall in our subject than in *Rissa* or in *Larus*; while posteriorly in *Orthorhamphus* there is thrown out, laterally, a delicate, transverse, osseous brace, which, when the quadrates are duly articulated, meets, on either side, the wall of the ear cavity, opposite their middle portions. For the left side, this brace shows fairly well in fig. 5 of Plate II.

All this part of the cranium in the skull of *Œdicnemus* at hand has been cut out and thrown away by the taxidermist who made up the skin of the specimen; so, unfortunately, I am unable at present to make the necessary comparisons with the skull of that species.

Anteriorly, the mesial, apical portion of the basitemporal area underlaps the entrances to the Eustachian tubes, the latter standing pretty well apart. This is likewise a Gull character; while in the Plovers those openings to the middle ear, on either side, are not so protected, and in them they may be seen upon a direct basal view of the skull.

Orthorhamphus, *Hæmatopus*, *Larus*, and others have a large *foramen magnum*, which is nearly circular in outline; in the typical *Charadriidæ* its longitudinal axis is generally longer than the transverse one.

This Long-billed Stone-Curlew of Australia possesses pterygoids at the base of its skull, which differ entirely from those found in the typical *Limicolæ*. Either bone is flat ventrally, sharp and thin dorsally, slightly twisted upon itself, does not meet the fellow of the opposite side in articulation, and *lacks entirely* any basi-pterygoid processes. In *Larus* and other *Longipennes* the pterygoid is more slender, markedly straighter, and does articulate anteriorly with the fellow of the opposite side in life.

There are no basi-pterygoid processes among the Gulls, Terns, and their near allies. Plovers have their pterygoids very short; they usually do not meet each other anteriorly in articulation, and basi-pterygoid processes are strongly developed throughout the typical *Limicolæ*. I find them present in *Hæmatopus*, *Charadriidæ*, *Numenius*, and in many allied species.

This being the case, the *pterygoids* of *Orthorhamphus* and *Œdicnemus* are much more like those bones in Gulls, in *Chiornis*, and others than they are in birds belonging to the typical *Charadriinæ*; while, on the other hand, a *quadrate bone* varies but little throughout the typical *Limicolæ* and *Longipennes*, including these big Stone-Plovers. As an element of the skull, the bone is found to be large and bulky in all of them, with a very broad, flattened, quadriform orbital process. The major anterior portion of the facet for the mandible is placed transversely, and presents the usual facets for articulation with the mandible as cited above.

An *orbital cavity* in *Orthorhamphus* is notably capacious with respect to its size, and in this particular agrees better with pluvialine birds than with the *Laridæ*. This, however, does not apply to the inter-orbital septum separating these two cavities,

for in all these Stone-Plovers it usually presents but a single, *not large*, vacuity near its centre, while in typical Plovers the partition is quite deficient, in so far as it is preformed in bone.

Owing to the kind of lacrymal our subject possesses, the orbital roof is likewise more complete and protective, in so far as the eye is concerned, in the Stone-Plover, the Chilean Lapwing, and some limicoline birds than it is in *Larus*, *Rissa*, and some of their near congeners.

Most Gulls, Oyster-catchers, Plovers, Lapwings, &c., have more or less perfectly ossified *pars planæ* forming the anterior walls of the orbits; and it is interesting to note that this osseous partition, dividing, in a way, the orbit from the rhinal chamber, upon either side, is present in *Œdicnemus*, but entirely absent in *Orthorhamphus magnirostris* and in *Chiornis*, in which forms these wings of the mesethmoid are found to be only in membrane.

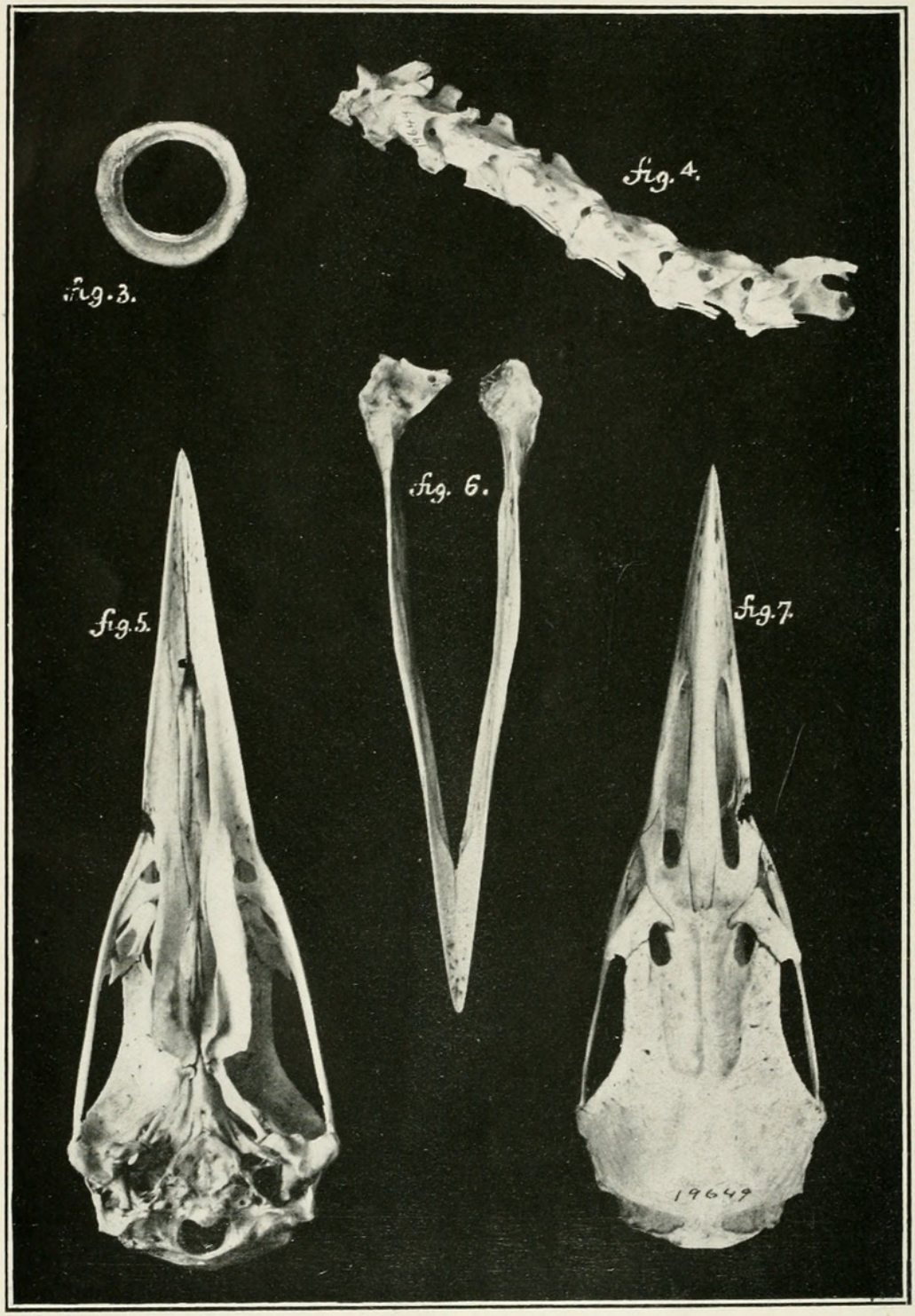
Owing to the formation of the crotaphyte fossæ, and the conspicuous post-frontal and squamosal apophyses with the deep valley between them, the entire facies of the lateral aspect of the cranium in *Orthorhamphus* comes closer to some of the Gulls than to any of the true Plovers. In *Œdicnemus bistriatus* the post-frontal process is very long and slender, almost reaching to the squamosal one below it; while in average Plovers, including the Lapwings (*Vanellus*, &c.), these lateral processes of the cranium are invariably short and inconspicuous, with the valley between them usually quite shallow.

The *zygoma* or *quadrato-jugal bar* is rather broad and compressed from side to side, its deepest part being the maxillary extremity, situated between the descending limb of the lacrymal and the nasal of the same side. This is the form of the infra-orbital bar in *Larus argentatus*, while in the typical Plovers (*Squatarola*, &c.) and the Lapwings it is very straight, slender, and uniform in its proportions, and its anterior extremity is in a much higher plane than the posterior (the long axis of the skull being held horizontally).

Larus argentatus, when adult, possesses, upon either side, an elongate, triangular flake of bone, about 7 millimeters long, which is attached by ligament to the hinder extremity of the descending limb of the lacrymal. It points directly backward, and is therefore parallel to the zygomatic bar. (Spec. No. 18,204, Coll. U.S. Nat. Mus.) I find no such ossicle as this in the skull of *Orthorhamphus*, nor in any of the typical *Charadriidæ*.

The free *vomer*, being bifid posteriorly, straddles the anterior sharp apex of the presphenoid. The bone is unusually long, laterally compressed, narrow from above, downwards, and carried, as it gently curves ventrad, to a bifurcated, sharp point in front. This agrees pretty well with what we find in *Œdicnemus bistriatus* and in the Oyster-catchers, in which last it is more evidently bifid anteriorly. With respect to *Larus*, beyond the presphenoid the vomer develops lateral wings of moderate width throughout, which are laterally disposed. These do not occur in our subject, nor in the *Charadriidæ*.

PLATE III.



Either *palatine* is conspicuously developed, and when articulated as in life these bones do not quite come in contact in the middle line. The postero-external angle is completely rounded off, while up to a point opposite the lower end of a lacrymal, the inner and outer edges of one of these bones are turned downward, especially the mesial edge. This creates a moderate concavity on the posterior third of the bone; while beyond it they are flat, with the lower or ventral surfaces somewhat inclined toward the mesial plane. These bones make the usual articulations anteriorly, and with the premaxillary and the maxillo-palatines; and in the skull of the adult nearly all the sutural lines are obliterated, especially with the premaxillary in the roof of the mouth.

As well as I can judge from the mutilated skull of *Œdicnemus bistriatus* at hand, its palatine bones agree quite closely with those of *Orthorhamphus*, though anteriorly they may be somewhat narrower. With some slight modifications, they also agree with the palatines as we find them in a great many of the *Limicolæ*, *Longipennes*, and their near congeners. (Fig. 5, Plate III.)

This agreement is also seen in the case of the *maxillo-palatines*, with the exception of the Oyster-catchers (*Hæmatopus*), in which genus, as I have previously shown, they are peculiar. In our subject, a maxillo-palatine nearly meets the scroll-like portion of the fellow of the opposite side in the middle longitudinal line, the vomer being well above the narrow interval between them. This interval is considerably wider in *Larus*, *Hæmatopus*, and most Plovers, and the vomer is more basally situated in them, thus bringing it into plainer view when the skull is regarded upon its ventral aspect.

The *maxillary* in *Orthorhamphus*, upon leaving the zygoma, is a thin, horizontal plate of bone; when half-way across to the scroll-like portion of the maxillo-palatine it bifurcates, and, the mesial ends expanding, the superior branch fuses with the superior margin of the scroll-like part, and the lower branch with the inferior margin of the same. This arrangement is quite different in Plovers, Gulls, Oyster-catchers, Turnstones, &c., as in these the osseous connecting bridge of the maxillo-palatine, on either side, is very short, and in some species quite inconspicuous.

Unfortunately, the *ossicula auditus* have been lost in the case of the skeleton of the species here being considered, so I cannot describe them. On the other hand, the *sclerotal platelets* of both orbits were saved (fig. 3, Plate III.) As is well known, the eyes in this bird are of great size; but these overlapping laminæ of bones present nothing peculiar beyond the fact that they are very narrow in front, and gradually become wider and wider as we pass backwards, the posterior ones being markedly wider than those in front.

Passing to the *mandible*, we find it to be a bone presenting some interesting characters. In form, it is of the narrow, acute V-shaped pattern (fig. 1, Plate II.; fig. 6, Plate III.), with deep rami, and strong, bulky articular extremities. Viewed laterally,

it is seen to offer a double curve in its entire length. From posterior end to apex, on either side, this curve is upwards, downwards, and again upwards. The symphysis is extensive, having a length of 2.5 centimeters, being extensively concaved above and correspondingly convex below. Inferiorly, the margins are rounded off, and this is true of the osseous tomia above, all to the distal dentary part, where they become sharp. A slit-like vacuity occurs in the splenial space, and a centimeter posterior to it, in either ramus, there is a small, perforating foramen. This foramen is very large and conspicuous in *Larus argentatus*, but minute in Plovers.

As already stated, the articular extremities are thick and strong, with their hinder aspects of a triangular outline, the plane of the superficies being at right angles to the long axis of the bone.

The cranium and this mandible, together with the free associated bones, are nearly entirely pneumatic, and this is generally the case in the other forms here mentioned.

In the Chilean Lapwing (*Belonopterus*) the mandible possesses well-developed angular processes posteriorly, and this is the case, too, in *Squatarola* ; while in most Gulls the mandible is very much like that bone in *Orthorhamphus*. In fact, this jaw would answer pretty well for some of the larger species of longipennine birds.

The Hyoid.—In this, the skeletal part of the lingual apparatus, we find extreme simplicity of structure. The anterior cartilaginous extension of the *glosso-hyal* is long (2.5 cms.) and narrow (average 1.5 mm.), terminating in front as a rather pointed tip. Basally it ossifies to a certain extent, forming a bone some 4 mm. long, and just large enough to accommodate the articulation for the *basi-hyal*. This latter is of quadrilateral outline, with the usual anterior, median process for the glosso-hyal, consisting of a short superior lip and a long inferior one. Posteriorly, its margin is transverse, and occupied by a median facet for the *free uro-hyal* or *basi-branchial*. On either side of this is the facet for the *cerato-branchial* of the *thyro-hyals* for the corresponding side.

Either *epi-branchial* ossifies all to a small part of its hinder end, and the cerato-branchial and epi-branchial taken together exhibit a considerable curvature, the first-named having a length of 3.2 cms. and the latter 2 cms., not including its cartilaginous part. (Plate II., fig. 2.)

In *Squatarola squatarola* no part of the *glosso-hyal* ossifies ; the *basi-hyal* is narrow and elongate, and the *uro-hyal* co-ossifies with it. The *thyro-hyals* are extremely slender and long, agreeing, apart from their smaller size, with those elements of the hyoid in *Orthorhamphus*.

Rissa tridactyla (No. 18,169, Coll. U.S. Nat. Mus.) exhibits considerable difference in its hyoid, as compared with the limicoline species just noticed. In this Gull a large part of the *glosso-hyal* ossifies—that is, some 1.3 cms. of its posterior portion, and only about 8 mm. of its anterior tip remains in cartilage in the adult. The ossified part is elongate and narrow (V-shaped), being composed of two small rods of bone placed side by side and bridged

across posteriorly, so as to afford the articulation for the basi-hyal. This latter is short and triangular, with a posterior extension for the uro-hyal, which latter does not seem to co-ossify with it. The *cerato-branchials* are very long, while the *epi-branchials* are short, and only ossify near their distal ends.

The *trachea* (with its superior and inferior larynx) is of very simple construction, and it is not my intention to devote any special attention to it here.

There are one hundred and fourteen rings in the "windpipe" portion of it, and its anatomy, in so far as its general structure is concerned, is well shown in fig. 2 of Plate II.*

The Remainder of the Axial Skeleton (fig. 8, Plate IV.)—*The Spinal Column.*—No little interest attaches to the number of vertebræ which normally occur in the vertebral spine in birds, especially when we come to compare such data in those species which belong to related groups. The significance of the information obtained may not always be at first apparent; but the time will arrive when it will be, for far in the future a day will come when we shall be in possession of a much wider knowledge of the morphology of birds than we now command.

In various published papers of mine upon avian osteology, there occur counts of vertebræ for many species among the waders and shore-birds. One or two of these may or may not occur in the following table, which contains representatives of the principal forms which have been taken into consideration in the comparative osteological study of *Orthorhamphus magnirostris*; in such connection it will prove to be useful.

TABLE.

Species.	Number cervical vertebræ without ribs.	Cervical vertebræ with free ribs.	Dorsal vertebræ.	Sacrals.	Free caudals to which the pygostyle is to be added.	Total.
Orthorhamphus magnirostris	13	14th, 15th	16–20	16	7	43
Hæmatopus niger ..	12	13th–15th	16–20	16	7	43
Chionarchus minor ..	13	14th, 15th	16–21	15	7	43
Squatarola squatarola	13	14th, 15th	16–21	14	7	42
Belonopterus chilensis	13	14th, 15th	16–21	14	7	42
Rissa tridactyla ..	13	14th, 15th	16–21	12	7	40
Larus argentatus ..	13	14th, 15th	16–20	14	7	43
Arenaria interpres ..	13	14th, 15th	16–20	12	8	40

* Unfortunately, in the average museum specimens of birds' skeletons the hyoidean apparatus and the complete skeletal parts of the air passages are not to be found. It is largely the case in the present instance, and I find myself without the tracheæ of either a Gull or a Plover at hand.

This table goes to show that, in so far as the *number* of vertebræ in the spine is concerned, *Orthorhamphus* has, in common with an Oyster-catcher, with a Sheath-bill, and with a Gull, 43 vertebræ, while with their *divisional lines* it agrees with no one of them. Finally, the only two birds that do agree in this particular—both numerically and divisionally—are two Plovers, *Squatarola* and *Belonopterus*, and as Plovers they are not especially closely related.

In the cervical region of the spine in *Orthorhamphus* the vertebral artery, upon either side, is generously protected by extensive osseous walls, provided in the usual manner by each succeeding vertebra of the neck. There is no semblance of a vertebral canal, however, provided on the part of the *axis* or the *atlas*, and in life the artery would appear to pass from the anterior entrance of the vertebral canal of the third cervical, across the axis, to within the neural canal of the atlas, and thence into the cranial cavity.

Neurapophyses appear on the second to the fifth cervicals inclusive, being well developed on the atlas, but then gradually diminishing in size as we follow them backward. They appear again on the last three or four cervicals, small at first, until to include the last one, which is more or less like one of the neurapophyses of the dorsal vertebræ. (Fig. 4, Plate II., and fig. 8, Plate IV.)

The *carotid canal* is open throughout its entire course, and the pleurapophysis, upon either side of it, is well developed.

The first *free cervical rib* is short, and more or less rudimentary; the second is long and very slender, lacking an unciform process.

All the *dorsal vertebræ* are freely articulated with each other, and this appears to be the case with all the birds mentioned in this paper. Their neural spines only come in contact with each other at the anterior and posterior extremities of their superior free and thickened margins. There they interlock in the usual manner through a pointed anterior ending and a bifurcated posterior one. These spines are quadrilateral in outline, their free anterior and posterior margins being concaved, thus forming elliptical vacuities between them, when duly articulated as in life.

Lateral processes of the dorsals are broad and flat, with all their accessory projections much reduced. Only the two leading dorsals possess hæmal spines, and they are not very conspicuously developed.

All the *dorsal ribs* and one pair of the sacral ribs—the first—bear *epipleural appendages*, and all are well developed with the exception of the sacral ones. These appendages overlap the succeeding ribs when articulated, and therefore materially add to the stability of the osseous thoracic walls. With respect to form, the ribs in *Orthorhamphus* are rather slender, and this likewise applies to the six pairs of hæmapophyses, which articulate with the costal borders of the sternum. Of these, the longest pair are those belonging to the first pair of sacral ribs; those belonging

PLATE IV.

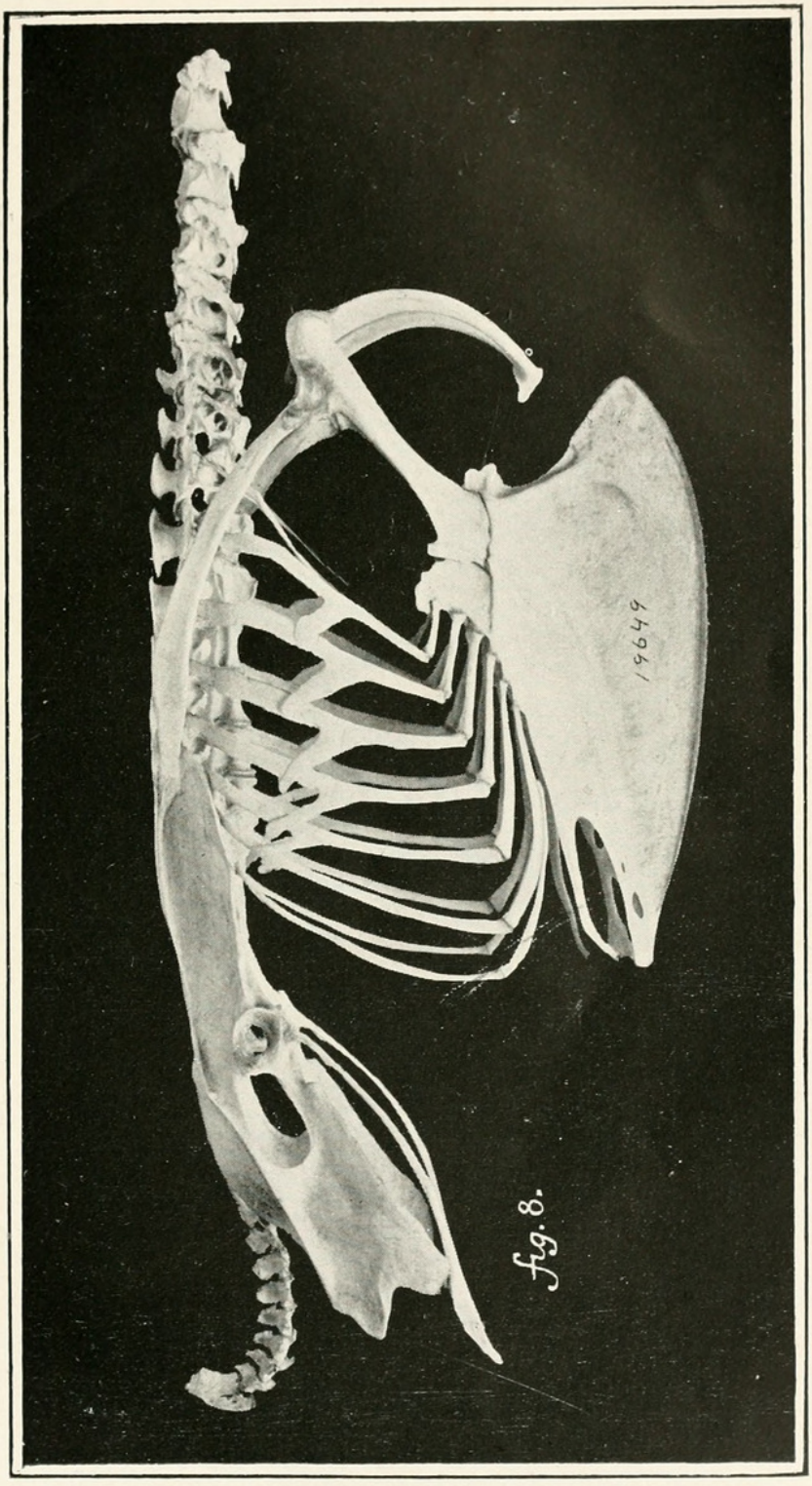


Fig. 8.

to the very slender second pair of sacrals do not reach, on either side, the sternum, by at least a centimeter or more. (Fig. 8.)

The Sternum (fig. 8, Plate IV.; fig. 10, Plate V.)—In this bone we have an interesting combination of characters; and, while these are largely pluvialine, there is yet to be seen evident traces of larine ones. Quadrilateral in general outline, the bone has an extreme length of $8\frac{1}{2}$ cms., and an average width of $3\frac{1}{2}$ cms. An imaginary line, measured from the postero-superior angle of the small, sessile, quadrilateral manubrium to the angle of the deep and anterior projecting carina, measures 3.3 cms., while the keel itself has an extreme length of 9.1 cms.

Dorsally, this sternum is markedly concaved, and does not appear to be pneumatic, as the foramen just within the thickened anterior border, mesially, is absent. There is a large, elliptical one present in *Larus argentatus*, and a small one in the sternum of a Kittiwake (*Rissa*).

The sterna of *Chionarchus*, most Plovers, Oyster-catchers, and Turnstones and their allies are non-pneumatic, and the aforesaid foramen is absent.

Orthorhamphus has the costal processes of its sternum large and almost square in outline, the posterior border of either one of them affording space for well-separated transverse facets for the three leading costal ribs or hæmapophyses. The manubrium stands squarely between the transversely long coracoidal grooves, and the sharp mesial anterior edge of the former is carried halfway down to the carinal angle, the anterior border of the keel being much thickened here, while for the rest of the distance to the angle it is thin and sharp.

Passing to the posterior part of the body of the sternum (figs. 8 and 10), we find a long, very slender, external xiphoidal process on either side, which very nearly surrounds a large, elliptical xiphoidal opening. These lateral processes nearly close in, on either side, the opening posteriorly. Mesially, the midxiphoidal prolongation is transversely broad, terminating posteriorly in a transverse border. On the left-hand side of the keel this prolongation is pierced by two foramina—one small, antero-external circular one, and one, rather large, postero-external elliptical one. On the right-hand side there are two more—a very small, antero-external circular one, and a much larger circular one, situated at a little distance posterior to it.

As a rule, Plovers have their sterna profoundly twice-notched on either side of the sternal keel (*Squatarola*, *Charadrius*, *Lobivanellus*, &c.); this is also the case with *Hæmatopus*.

Belonopterus chilensis has large, external "notches" and much smaller internal foramina, this being reversed in *Larus argentatus*. *Chionarchus minor* agrees, in this particular, with *Rissa tridactyla* and probably with other Gulls, all of which proves that we must be quite cautious when we come to employ the morphology of the xiphoidal extremity of the sternum of birds as the sole character in tracing affinities in this group.

The Pectoral Arch.—All the bones composing this part of the skeleton in *Orthorhamphus* are strongly developed and of conspicuous size (fig. 8, Plate III., and figs. 9 and 10, Plate IV.)

When articulated, as in life, the *scapulæ* extend several millimeters posterior to the anterior limits of the ilia of the pelvis; a *coracoid* exceeds in length half of the longitudinal axis of the body of the sternum; and the broad, U-shaped *os furcula*, with its small, peg-like hypocleidium, is, comparatively speaking, much stronger than it is in certain *Laridæ* possessing a trunk skeleton of proportions equalling that of the present subject.

Below, the os furculum stands well away from the anterior margin of the sternum, being separated by at least a centimeter. Mesially, below, this bone is compressed from before, backwards, while the clavicular limbs above are flattened transversely. Superiorly, the distal end, on either side, makes a substantial articulation with the scapula, and a very extensive one with the head of the corresponding coracoid as it passes it. Thus, it will be seen that the formation of the *foramen triosseum* is very complete in *Orthorhamphus*.

As in Plovers and Gulls, but not in Oyster-catchers, the *coracoids* are separated from each other in their sternal grooves or beds by the posterior portion of the manubrium. At its lower part, either one of these bones is much compressed from before, backwards, and much expanded transversely. Both externally and mesially on this expanded portion below, there is developed an apophysis which, in either case, is directed upwards, almost parallel to the longitudinal axis of the bone. Of these two processes, the outer one is the larger, and is constantly present. The inner one appears to be an ossification of the ligament which is attached at the infero-mesial angle of the coracoid, and consequently may or may not be present, depending on the age of the individual. Indeed, as Dr. Gadow remarks, the "configuration of the various processes of these bones is manifold, and of great taxonomic importance, as has been exhaustively shown by Professor Fürbringer, in whose *Untersuchungen zur Morphologie und Systematik der Vogel* about one hundred figures of this articulation in different birds are given.*

The precoracoidal process extends nearly half-way down the shaft, and is pierced below by the foramen for the supracoracoidal nerve, as in the *Strigidæ* and some other birds, as many *Limicolæ* and *Laridæ*.

For its anterior moiety a scapula is somewhat narrow and thick, being broader, with a thin, truncate blade behind, the whole bone having a cimeter-form, with sharp edges for its posterior third. Anteriorly it makes an extensive and close articulation with the coracoid, and is, on either side, in contact with the free posterior extremity of the clavicular arch or *os furculum*.

* Gadow, Hans, Newton's "Dict. of Birds," p. 856. In the figures given here, the lettering is incorrect, in so far as the pectoral arch of *Bubo ignavus* is concerned, as Acd is made to indicate the scapula instead of the letters Sc.

A coracoid has a height of 4.5 cms.; a scapula a length of 6.2 cms., measured on the chord of its arc; the distance between the free extremities of the os furculum is 2.5 cms., measured within their arch, opposite the heads of the coracoids.

From the above description it will be seen that in its pectoral arch *Orthorhamphus* agrees with some of the typical Plovers and their near allies, as *Squatarola*, *Lobivanellus lobatus*, and others, wherein the scapulæ are long, those bones being much shorter, relatively, in the Lapwings.

The character of the pectoral arch in the *Laridæ* presents a number of points not found in the limicoline species mentioned, a prominent one being a "shoulder" on the outer aspect of either free end of the *os furculum*.

In *Chionarchus minor* a coracoid is almost the counterpart of that bone in *Rissa tridactyla*; the *os furculum* is thin and flat, and, although U-shaped, has a form peculiar to itself. The scapula has both pluvialine and larine characters in it.

Pelvis and Coccygeal Vertebræ (fig. 8, Plate IV.; figs. 9 and 10, Plate V.)—Apart from such characters as it presents which are *sui generis* with respect to this species, the *pelvis* of *Orthorhamphus magnirostris* is distinctly in agreement with that bone as we find it in the skeletons of average Plovers and some of their allies. It is a different style of pelvis altogether from what we find in the *Laridæ*, in so far as I have examined the osteology of that family.

Anteriorly, the *ilia* are broad, much concaved and spreading, with their anterior margins rounded and finished off with a raised rim (fig. 9). Mesially they are, for a distance of about 2 cms., in close contact with the neural crest of the fused vertebræ of the anterior portion of the pelvic sacrum. Posterior to this contact, the ilia again diverge from each other at rather a smart angle, forming, as they do, the outer wall on either side to the posterior entrances to the "ilio-neural canals."*

Viewed upon lateral aspect, it will be observed that the *cotyloid cavity* or *acetabulum* of this pelvis is relatively of small size, and that the foramen at its base measures but 4 mm. in diameter. There is a small *prepubic process* present, and the antitrochanter is small and faces almost directly forwards. Posteriorly, the "obturator foramen" is very open; indeed, this foramen and the large "obturator space" behind it form, in this pelvis, practically one vacuity (fig. 8). Above it, anteriorly, the *ischiadic foramen* is large and of a broad elliptical outline.

Beneath the obturator space, the *post-pubic element* is narrow, thin, and curved, until it comes in contact for about 5 millimeters with the infero-posterior angle of the ischium, after which it slightly broadens, curving mesiad to terminate in a deep, free point behind. Laterally, the *ischium* is broad and smooth; projects very considerably beyond the end of the consolidated

* Owen, Sir Richard, "Comp. Anat. and Phys. of Verts.," vol. ii., p. 32.

sacral vertebræ or "sacrum," and exhibits a deep "ischiadic notch" on its posterior margin.*

Viewed upon its dorsal surface, there is to be noted the parial intervertebral foramina, which, beginning small at the posterior apertures to the ilio-neural canals, continue so as to include the fifth pair, whereupon they become very considerably larger, being elliptical in outline, and maintain nearly a uniform size to the ultimate pair.

The sacrum is broadest at a point between the trochanters, and narrowest at its posterior termination, the margin joining these two points, on either side, being nearly a straight one. This line or sacral margin is likewise in close contact with the opposing border of the ilium, and it is very probable that in old individuals these two elements of the pelvis may anchylose along these borders; they appear to be nearly in that condition in the specimen at hand.

The post-acetabular part of either ilium, on this view of the pelvis, is convex throughout its extent for the anterior three-fourths of its area, while the hinder fourth is decidedly concave, which concavity is limited behind by the free margin of the ilium, and at the side by the conspicuously raised and sharp border of the same pelvic element. This latter border forms the *internal* edge of an ilium, as far back as a point opposite the cotyloid cavity, after which it forms the raised bounding crest standing between the post-acetabular area and the side of the pelvis.

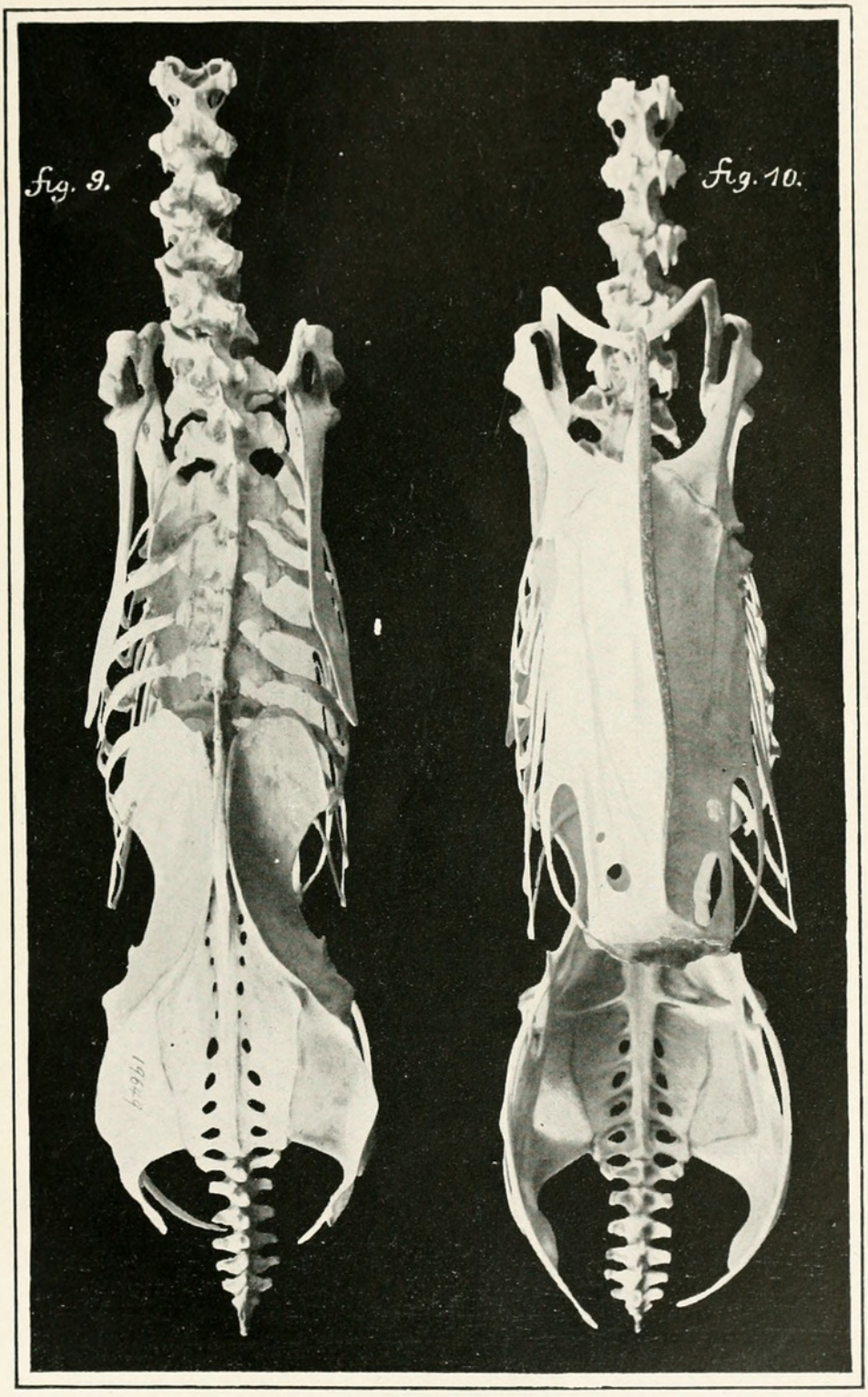
On its ventral aspect we have to observe the capacious *pelvic basin* of this bone, and the not very strong pair of transverse processes of the eleventh sacral vertebra, which are carried far out, transversely, as braces to points slightly posterior to the antitrochanters. Beyond this, the united centra of the sacral vertebræ exhibits, as usual, considerable enlargement in order to accommodate the increased size of the spinal cord in this part of its continuity. In the present instance, this enlargement is somewhat above the average for a bird of this size; it is hidden by the sternum in fig. 8 of Plate V.

The ventral surfaces of the ilia are flat and smooth throughout their entire extent, and the two pairs of sacral ribs, where they come in contact with these surfaces, completely anchylose therewith throughout the entire line of meeting. The fourth, fifth, and sixth sacral vertebræ have their transverse processes extended laterally as braces to the ventral surfaces of the ilia opposite them, and it is at this point that the pelvis of *Orthorhamphus* is narrowest transversely.

As already stated above, the skeleton of the tail in this bird consists of seven vertebræ and the *pygostyle*. This latter has a

* Doctor Gadow, in describing "the Pelvic Arch" in the article "Skeleton" in Newton's "Dictionary of Birds," letters this notch *inc. isch.*; but nowhere states what those letters stand for. This likewise applies to the letters *Inc. isch. pub.* for the obturator space (obturator vacuity or obturator interspace of Owen) in the same work.

PLATE V.



sharp anterior and a thickened posterior edge, the bone, as a whole, curving from base to apex. It is pierced by a small foramen at its postero-inferior angle, indicating the point between the hæmal spines of the otherwise indistinguishably fused eighth and ninth caudal vertebræ. Unfortunately, the apex of this pygostyle was broken off and lost when the skeleton was loaned me, but it would appear to have been quite pointed.

The neural spines of the first four caudal vertebræ are short and thick, while fairly well marked antero-posterior grooves at their apices make them appear as though each were moderately bifurcated.

The neural spines of the last three caudals become gradually more and more rudimentary as we proceed toward the pygostyle. These last three vertebræ, however, possess hæmal spines which are lacking in the four preceding them. No *chevron bones* appear to be present, and the diapophyses of all these caudal vertebræ, save the ultimate one, are well developed, they gradually becoming shorter and shorter as one follows them toward the coccyx.

The Pectoral Limb (figs. 12, 13, Plate VI.)—That this Stone-Plover is a good flyer is evidenced by the bones of the skeleton of its wings, and, although none of them enjoy pneumaticity—not even the humerus—they are nevertheless strong, and possess lengths in keeping with the balance of the skeleton. In the main, they are all rather slender and straight, the shaft of no one of them presenting any marked curvature, even the usual sigmoid curves of the shaft of the humerus being much less evident than in some birds representing other groups not intimately related to the *Limicolæ* or the *Longipennes*. By measurement I ascertain the lengths of these bones to be as follows* :—

Humerus	102	millimeters.
Radius	113	,,
Ulna	117	,,
Carpo-metacarpus	50	,,
Proximal phalange of index digit	22	,,
Distal one	21	,,
Phalange of pollex without the claw	14	,,

The caput humeri of the *humerus* is rather large and hemi-ellipsoidal in form. To its radial side there is an extensive, flat facet for the insertion of the pectoralis secundus muscle.† It stands at the proximal termination of the radial crest. This latter is an extensive process, bent palmad, its outline being

* Should these measurements not agree with the figures in the Plate, it may be due to the fact that they were not followed by the half-toners in reproducing my photographs of the specimens. As submitted, the latter were slightly above natural size, in order to ensure sharpness in reproduction.

† Shufeldt, R. W., "Myology of the Raven," p. 72. A very full synonymy of this muscle is here presented, made by Dr. Hans Gadow (Bronn's *Klassen*, VI. Band, p. 246).

hemielliptical, with the free margin finished off with a thickened edge. (Length, 22 mm.; height, 7 mm.) In outline and other particulars this "radial crest" agrees with that part of the humerus in *Chionarchus minor* and *Hæmatopus niger*; while in *Squatarola* and *Belonopterus* it is relatively shorter and rather more pointed at the centre of its free margin, and decidedly more so in most *Laridæ*. In *Arenaria interpres* it is also pointed, with the point slightly bent palmad.

The "incisura capitis" is deep, and has a length equalling that of the head of the bone. To its ulnar side is to be noted the deep excavation, entirely surrounded proximally by a raised margin, known as the "pneumatic fossa," but here harbouring no foramina for that purpose. At its summit, proximad, there is a prominently developed tubercle—the tuberculum internum. On the palmar aspect of the head of this humerus the "incisura capitis" is deep and long, and the area immediately beyond it—the roof of the pneumatic fossa, as it were—is smooth and convex. As already stated, the subcylindrical shaft is but slightly curved, and, beyond its smoothness, lacking in any particular character.

At the distal extremity neither the enti- or the ecti-condylar process is especially prominent (fig. 13); while the latter in such birds as *Chionarchus minor*, many *Limicolæ* and *Longipennes*, is a very conspicuous character of the humerus.

The excavation for the insertion of the brachialis anticus muscle is rather deep, and the articular tubercles beyond it are prominently developed.

Upon comparing, character for character, as presented on the part of all the humeri at hand at this writing, I find that the humerus of *Orthorhamphus magnirostris* is much more like the humerus in *Hæmatopus niger* than it is like that bone in any other species; and when I say this, it must be remembered that I have not a humerus before me from a specimen of *Œdicnemus*. Indeed, the skeleton of the limbs in the case of that genus lacks the femora, the humeri, the proximal ends of the tibio-tarsi and radii, and of one ulna.

Neither the *radius* nor the *ulna* in *Orthorhamphus magnirostris* present any peculiar characters. Either bone has the usual curvature of its shaft at the proximal third, so that, in the articulated limb, we find there a much larger "interosseous space" than exists between these bones for the remaining two-thirds, distad. Their shafts are smooth, and more or less cylindrical in form at the middle sections of their continuities. Ulna almost entirely lacks the papilliform elevations down its shaft for the quill-butts of the secondary feathers, which are more or less prominent in most *Laridæ*, some *Charadriidæ*, and the Oyster-catchers.

Possessing the usual ornithic characters, as they pertain to birds of the higher groups, the *radiale* and *ulnare* ossicles of the carpus are both present, well developed, and make the usual articulations with the bones of the antibrachium and manus.

The skeleton of the *manus* consists of the *carpo-metacarpus*, the phalanx of *pollex*, which latter supports a small *claw*, and the usual phalangeal joints of the *index* and *middle digits*. The radial or outer metacarpal bone of the carpo-metacarpus is elongate and tilted upwards. It is at the extremity of this co-ossified element of the hand that we find the osseous core of the spur in the Chilean Lapwing (*Belonopterus chilensis*) permanently attached by osseous fusion.

The proximal phalanx of the *index digit* and its expanded portion is not perforated as we see it in many Gulls, where it has two vacuities, one above the other, and each often of considerable size.

There is no claw on the distal phalange of the indicial digit, and this is the longest joint in the hand.

Chionarchus has the pollex metacarpal elongate, but it is at right angles to the long axis of the bone, while the Plovers and Oyster-catchers have it of medium size. *Œdicnemus bistriatus* agrees in the matter of the characters of the skeleton of its pinion with *Orthorhamphus*, with the exception that I do not find any distal claw on the pollex phalanx.

The Pelvic Limb (fig. 11, Plate VI.)—In so far as its legs are concerned, *Orthorhamphus magnirostris* is a much shorter-limbed bird than *Œdicnemus bistriatus*, as the following table will show :—

TABLE.

(Lengths in millimeters.)

Species.	Femur.	Tibio-tarsus.	Tarso-metatarsus	Mid-anterior toe.	Outer toe.	Inner toe.
O. magnirostris	65	118	87	44	44	35
Œ. bistriatus ..	?	135 (approx.)	123	44	38	29

The shaft of the *femur* is quite staight, smooth, and subcylindrical in form, and, as in the case of the pectoral limb, it is, with the remaining bones of the leg, non-pneumatic. *Caput femoris* is marked on top with a shallow, though extensive, pit for the *ligamentum teres*, the entire head of the bone being below the summit, which latter is smooth and convex from before, backwards. To the outer side of this surface there projects, slightly upwards, the *trochanter major*, while the major portion of that process extends directly forwards beyond the shaft of the bone (fig. 11). On the outer aspect of this trochanterian enlargement the surface is raised here and there for the insertion of muscles. Distally, the condylar extremity of the femur is massive, and seemingly out of proportion with the proximal end of the bone. The *rotular channel* between the condyles, anteriorly, is both deep and broad, while the latter exhibit definite beginnings

on the shaft. The popliteal depression on the posterior aspect distally is unusually deep and extensive, and it is bounded internally by a sharp and conspicuous crest, which extends up the shaft from the condyle. One finds the usual fibular cleft on the outer condyle, which is here deeply sculpt with prominent sides. Distally, the internal condyle supports a rather large, sub-triangular *flat* facet, which in life articulates with a perforated pad of cartilage resting on the summit of the tibio-tarsus. There is a distinct pit on the outer side of either femoral condyle, and these are for the insertion of the lateral ligaments.

At the knee-joint there is a small *patella*, which is broadly cordate in form, it being broad above where it is transversely concaved, with otherwise more or less sharpened borders.

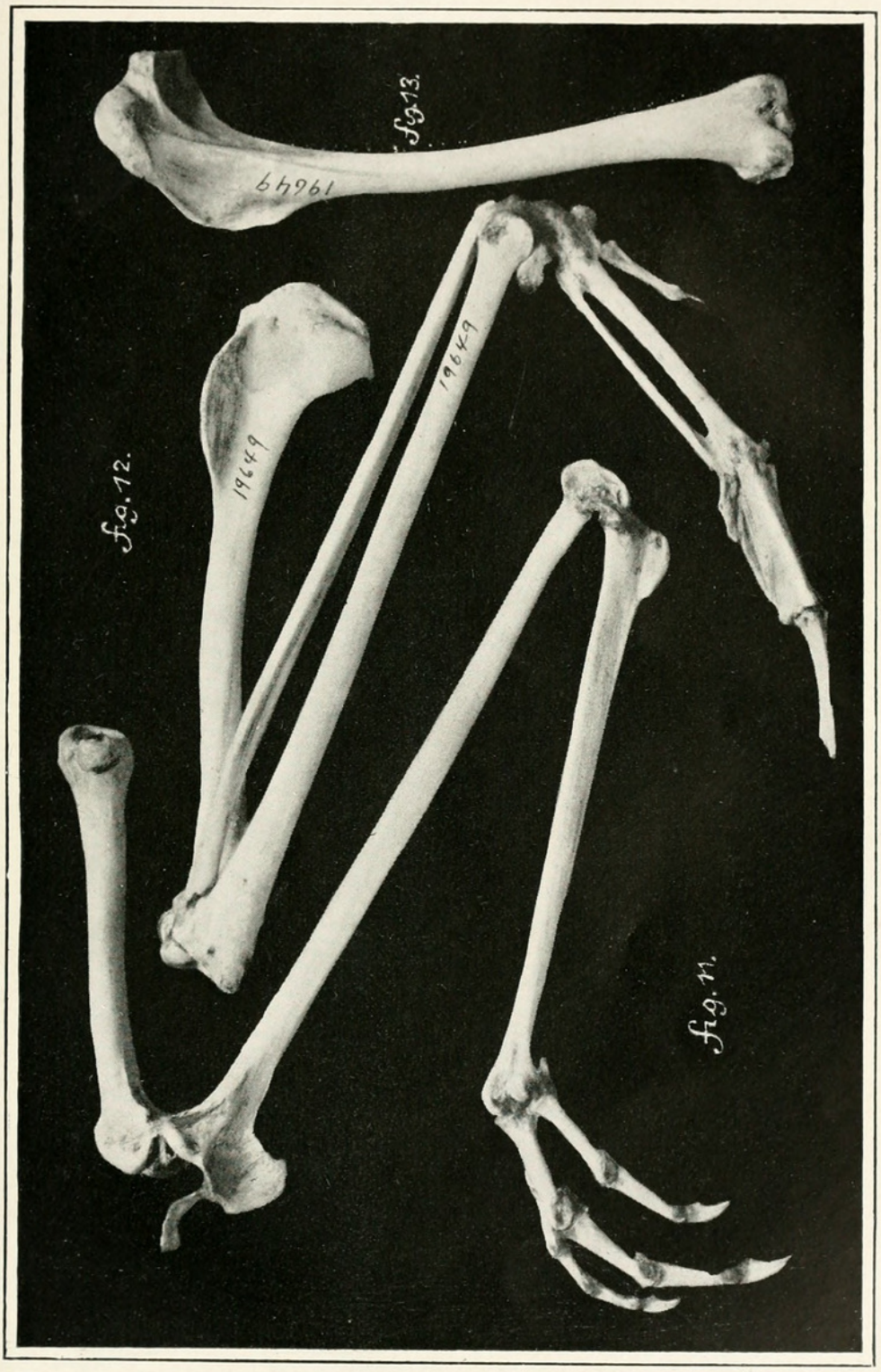
From one end to the other, the *tibio-tarsus* is a perfectly straight bone, smooth, and of nearly cylindrical form. The non-extensive "fibular ridge," about a centimeter and a half long, commences at a point about a centimeter below the head. The summit, at right angles to the long axis of the bone, is marked with the usual elevations and depressions to accommodate the large femoral condyles. Above this surface rises the rather low cnemial crest, with both ecto- and ento-cnemial projections well developed. The first is the smaller of the two, and points directly outwards from the end of the bone, the second, thin and quadrilateral in outline, is directed anteriorly, being placed a little obliquely on the shaft, with its supero-external rounded angle outermost as well as innermost, with respect to its distance from the head of the bone. This latter projects beyond the shaft all around, until it arrives at the fibular articulation, where quite a valley occurs between its termination and the ecto-cnemial process.

Distally, the rather small condyles are both reniform in outline, with raised borders. Both anteriorly and posteriorly they terminate abruptly on the shaft, not feathering away upon it as in some birds. An "osseous tendinal bridge" is present anteriorly, spanning the tendinal groove. To the outer side of its proximal entrance there occurs a minute foramen.

Orthorhamphus possesses rather a small and slender *fibula*; it articulates with the outer side of the shaft of the tibio-tarsus in the usual manner. This is here very close with the entire length of the tibia, with which bone it fuses at its lower end, at a point rather below the middle of the shaft.

Coming to the *tarso-metatarsus* (Plate VI., fig. 11), it will be seen that the bone presents no curvature whatever, the entire shaft being perfectly straight between the two extremities. Anteriorly, it is conspicuously grooved longitudinally from one end to the other, the gutter being deepest down the proximal moiety, and becoming gradually more and more shallow down the distal half, till it deepens again between the middle and outer trochleæ, in which latter narrow groove we find the foramen for the anterior tibial artery. Both sides of the bone are flat, while posteriorly

PLATE VI.



there is only a narrow tendinal groove running down the proximal half of the shaft.

Hypotarsus is short and quadrilateral in form. It is composed of an outer and an inner portion, the latter being the longer of the two. They are joined superiorly by a transverse, osseous bridge, which is longitudinally pierced by a single tendinal foramen. This passes into the valley or groove which stands between the two crests of this hypotarsial projection distally.

The usual two foramina are found on the anterior aspect of the shaft, side by side, just above the small, low, elongate ridge upon which the tendon of the *tibialis anticus* muscle is inserted in life. These foramina pass directly through the shaft of the bone, one appearing upon either side of the hypotarsus posteriorly.

At the summit of this bone, the intercondylar tubercle is conspicuously developed, and the condylar depression upon either side of it is somewhat deeper than we usually find it in many birds.

Distally, the three trochlear processes are of large size, as compared with the shaft that supports them. The inner one is the most elevated, and projects next farthest posteriorly, as compared with the one for the outer toe, which slightly exceeds it in this respect, and is situated nearly as high on the shaft. The largest trochlear projection is the middle one, and it is at the same time the lowermost on the tarso-metatarsial shaft.

This bird possesses no *hallux*, and the *first metatarsal* is entirely absent, which is also the case in *Œdicnemus bistriatus*, in which species the tarso-metatarsus, being considerably longer than it is in *Orthorhamphus*, agrees with it otherwise very closely in the foregoing characters.

There is no especial agreement between this tarso-metatarsus of *Orthorhamphus* and the same bone in any of the *Laridæ* or in *Hæmatopus*, and still less in *Chionarchus* ; while, upon the other hand, it holds many characters in common with the tarso-metatarsus of the Chilean Lapwing (*Belonopterus*), and in all likelihood with other *Charadriidæ*. In most of the limicoline forms, however, the *hypotarsus* is different ; for, while short and of approximately the same form, it is generally twice grooved posteriorly instead of only once, as it is in *Orthorhamphus*.

Sesamoidal bones of various sizes according to their location occur at the plantar extremities—both distal and proximal—of the basal phalanges of pes, the largest and most important one being situated in the " sole of the foot " at the proximal end of the basal joint of the mid-anterior toe, where it covers entirely the plantar aspect of the mid-trochlear process of the tarso-metatarsus.

The *phalanges of pes* (Plate VI., fig. 11) are stouter, joint for joint, than the corresponding ones in the foot of *Œdicnemus bistriatus*, the arrangement being the same in both birds—that is, 3, 4, and 5 joints to the second, third, and fourth foes respectively, or the inner, middle, and outer ones.

As in the case of the bones of the thigh, leg, and tarsus, the skeleton of the foot in *Orthorhamphus* has more Plover in it than has that of any other bird thus far examined by me.

RELATIONSHIPS OF ORTHORHAMPHUS.

Nearly all ornithological writers and systematists place this genus of birds among the *Charadriiformes* and in the family *Charadriidæ*.

As already pointed out, Sharpe has the genus in his family *Œdicnemidæ*, the sole family representing the sub-order (VI.) ŒDICNEMI, which sub-order is followed next by a similar group (VII.) OTIDES, to contain the sole family *Otididæ*, or Bustards and their allies.

In characterizing his *Schizognathæ* as a sub-order of birds, and differentiating the *Charadriomorphæ* as a group of the same, he seems to have overlooked the fact that these "Stone-Plovers" (*Œdicnemidæ*) are holorhinal and not schizorhinal birds (P.Z.S., 1867, pp. 456, 457).

In my own classification (*Amer. Nat.*, 1904, p. 851), the CHARADRIIFORMES are a super-sub-order (X.), in which a super-family, *Otidoidea* (II.) is created to contain the *Œdicnemidæ* and *Otididæ*, and this is substantially my view of the relationships at the present time, though I have always entertained the opinion that there is by no means a narrow gap between the Stone-Plovers and the Bustards. The relationship here is not nearly as intimate as some ornithologists would have us believe. For example, Newton says in the "Dictionary of Birds" (article "Curlew," p. 130), in speaking of *Œdicnemus* (*crepitans*):—"This Curlew seems to have been an especial favourite with Gilbert White, in whose classical writings mention is often made. Its range extends to North Africa and India, though examples from the latter country have been regarded as requiring specific distinctions. Four other species of *Œdicnemus* from Africa are recognized by Seebohm (*op. cit.*, p. 71. [That is, the Geogr. Distrib. *Charadriidæ*.])

"Australia possesses a very distinct species, *Œ. grallarius*, which some writers have raised to a genus, *Burhinus*, and there are three species in the Neo-tropical Region (*Œ. bistriatus*, *Œ. dominicensis*, and *Œ. superciliaris*). The analogy of all these birds to the *Otididæ* (Bustard) is manifest, but that they have any really close affinity to that family is questionable. An exaggerated form of *Œdicnemus* is found in *Æsacus*, of which two species have been described—one, *Æ. recurvirostris*, from the Indian, and the other, *Æ. magnirostris*, from the northern parts of the Australian Region."

This opinion of Professor Alfred Newton's coincides with my own exactly; and, from what I know of the osteology of *Otis tarda*, I can fully endorse his view as to the questionableness of any near affinity between the *Œdicnemidæ* and *Otididæ*. I only arrayed them in my classification, cited above, as I have for the

PLATE VII.

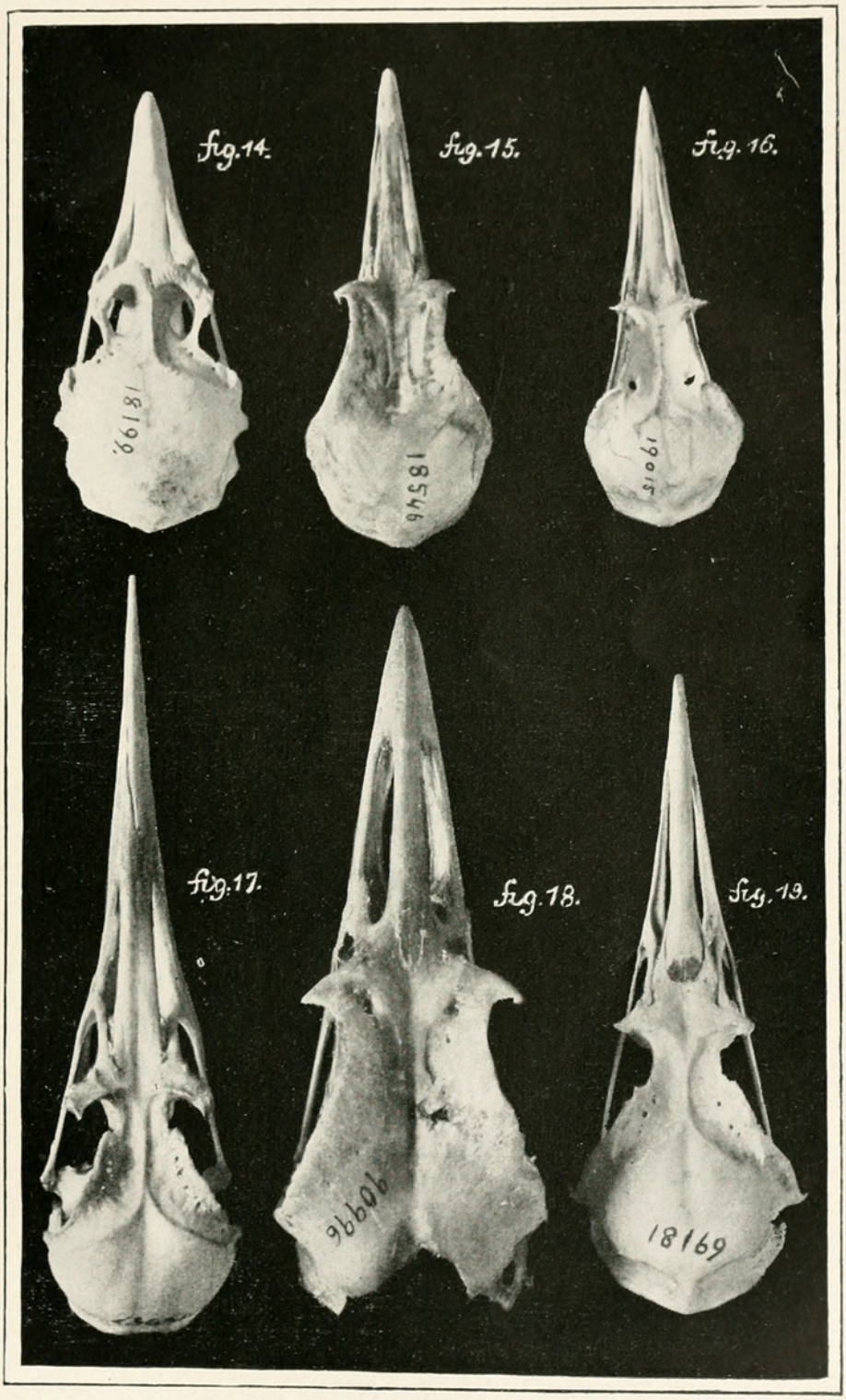


fig.14.
18199
fig.15.
18546
fig.16.
fig.17.
fig.18.
10996
fig.19.
18169

sake of present convenience—in other words, provisionally, until we know far more about the *entire morphology* of these birds than we do at the present time.

What has been brought out in the present paper finds its greatest interest in the added support it brings to what Huxley long ago pointed out—that is, the more or less near relationship of the great Plover-Snipe group of birds to the *Longipennes* and some of their congeners.

These *Œdicnemidæ*, in fact, in so far as their osteology goes, beautifully bridge across one of the gaps here, for we find both pluvialine and larine characters intimately blended all through the skeleton of *Orthorhamphus magnirostris*, and this is doubtless true of all the other typical "Stone-Plovers." Some of these osteological characters are typically those of a Plover, while others are equally so of a Gull. For example, were the skeleton of a fossil adult *Orthorhamphus magnirostris*, embedded in its matrix, handed to me, and I found only the posterior portion of the skull and mandible exposed, I would, upon viewing that, without the slightest hesitation, pronounce it as belonging to some typical representative of the genus *Larus*, and so on for other special regions of the skeleton of this group-linking species of bird.

EXPLANATION OF PLATES.

PLATE I. (¾ nat. size).

(All the figures in the Plates II.–VII. are reproductions of photographs made direct from the specimens by the author.)

Left lateral view of the head of an adult ♂ specimen of *Orthorhamphus magnirostris*. (No. 201,677, Coll. U.S. Nat. Mus.) By the author. Collected by Dr. Edgar A. Mearns, U.S. Army, on Loran Island, off South Ubian Island, P.I., 12th October, 1906. Shot by General Leonard Wood, U.S. Army.

PLATE II. (¾ nat. size).

Fig. 1.—Left lateral view of the cranium and mandible (disassociated) of *Orthorhamphus magnirostris*. Adult ♂ (No. 19,649, Coll. U.S. Nat. Mus.)

Fig. 2.—Left lateral view of the *hyoid arches* and the *superior larynx* and *trachea* (*in situ*). Same individual which furnished the skull for Fig. 1.

PLATE III. (¾ nat. size).

(All the figures in this Plate are of bones from the same skeleton as Plate I. (No. 19,649, Coll. U.S. Nat. Mus.))

Fig. 3.—Direct externo-lateral view of the circlet of *sclerotal plates* from the left eye.

Fig. 4.—Left lateral view of the leading eight (8) cervical vertebræ of the spinal column; these are continuous with the vertebræ shown in Plate III., fig. 8, and Plate IV., figs. 9 and 10.

Fig. 5.—Direct inferior view of the cranium of *Orthorhamphus magnirostris*. Same skull as fig. 1, mandible removed.

Fig. 6.—The mandible belonging to the skull shown in figs. 1, 5, and 7 of Plates I. and II. Seen from above.

Fig. 7.—Direct superior view of the cranium of *Orthorhamphus magnirostris*. Same skull as in figs. 1 and 5; mandible removed. A shot-hole is seen at the anterior extremity of the maxillary process of the right nasal bone, and this mutilation likewise shows in fig. 5.

PLATE IV. (about $\frac{5}{8}$ nat. size).

Fig. 8.—Right lateral view of the trunk skeleton of *Orthorhamphus magnirostris*. Same skeleton as before. The height of the *coracoid* in the specimen equals 46 millimeters (fig. 8). The superior apex of the pygostyle has been broken off.

PLATE V. (about $\frac{5}{8}$ nat. size).

Fig. 9.—Direct dorsal view of the same trunk skeleton as shown in fig. 8, Plate IV. *Orthorhamphus magnirostris*. Length of *sacrum* in life equals 73 mm.

Fig. 10.—Direct ventral view of the same trunk skeleton as shown in figs. 8 and 9. *Orthorhamphus magnirostris*. Length of *carina of sternum* in life equals 78 mm. Note the irregularity of the xiphoidal foramina.

PLATE VI. ($\frac{3}{4}$ nat. size).

Fig. 11.—Direct lateral view of the right pelvic limb of *Orthorhamphus magnirostris*. Same skeleton as before. The small *patella* is still attached to the dried ligament below. In this skeleton there is no *first metatarsal* nor *hallux* present.

Fig. 12.—Direct palmar aspect of the *pectoral limb* of *Orthorhamphus magnirostris*. Same skeleton as before (fig. 11, &c.) The phalange of *pollex* bears a small claw.

Fig. 13.—Direct anconal aspect of left *humerus* from the skeleton of a specimen of *Orthorhamphus magnirostris*. Although this bone is marked No. 19,649, it does not belong to the same skeleton which furnished the figures for Plates I.–IV. (figs. 1–12). The left humerus that belongs with that skeleton was made imperfect by a shot-fracture, and its distal half lost. The present bone was put in to replace it (and marked 19,649!) The humerus in fig. 12 of this Plate has a length of 100 mm., while the one here figured has a length of 104 mm.

PLATE VII. ($\frac{3}{4}$ nat. size).

Fig. 14.—Superior view of the skull of *Chionarchus minor*, mandible removed. (No. 18,199, Coll. U.S. Nat. Mus.)

Fig. 15.—Superior view of the skull of *Belonopterus chilensis*, with mandible articulated. (No. 18,546, Coll. U.S. Nat. Mus.)

Fig. 16.—Superior view of the skull of *Squatarola squatarola*, with mandible articulated. (No. 19,015, Coll. U.S. Nat. Mus.)

Fig. 17.—Superior view of the skull of *Hæmatopus niger*; mandible removed. (No. 13,636, Coll. U.S. Nat. Mus.)

Fig. 18.—Superior view of the skull of *Œdicnemus bistriatus*; mandible articulated. (No. 90,996, Coll. U.S. Nat. Mus.) This skull was apparently obtained from a discarded skin, as the entire occipital and basilar portions have been cut out and thrown away.

Fig. 19.—Superior view of the skull of *Rissa tridactyla*; mandible removed. (No. 18,169, Coll. U.S. Nat. Mus.)

New Records for South-Western Australia.

By W. B. Alexander, M.A., Keeper of Biology, Western Australian Museum, Perth.

On the retirement of Mr. B. H. Woodward, Director of the Western Australian Museum and Art Gallery, the collection of birds has come into my charge. In the course of re-arrangement and revision of names, which I have been undertaking during the last few weeks, I have discovered that there are specimens of several species in the collection which had not previously been recorded from south-west Australia. I have only carried the process of revision as far as the latest part of Mr. Gregory M. Mathews' "Birds of Australia" goes, but propose to continue as each part of that work appears.

Porzana fluminea (Gould). Australian Spotted Crake.

The "Official Check-list" gives Queensland, New South Wales, Victoria, South Australia, and Tasmania as habitat. Mr. Mathews has separated the South Australian bird under the subspecific name of *whitei* (*Austral Avian Record*, vol. i., p. 73), characterized by being "much lighter grey on the under surface." The examples before me, a male and a young bird only partly fledged, were collected at Herdsman's Lake, near Perth, by Mr. Ostle, in January, 1901. The male appears to agree in every respect with the description given in Mathews' "Birds of Australia," vol. i., p. 212, but its breast is considerably darker grey than that of the specimen shown in the accompanying figure, which is a "male, collected near Adelaide, South Australia." I conclude, therefore, that the Western Australian bird agrees with *P. f. fluminea*, and not with *P. f. whitei*, as might have been anticipated. I have, however, no skins from the eastern States with which to compare it.

Diomedea chlororhynchus (Gmelin). Yellow-nosed Albatross.

There is a specimen of this bird in the Museum which was obtained at Cottesloe Beach, near Fremantle, by Mrs. Campbell, in 1901. The species is not infrequent off the coast in winter, especially off Albany, and the Check-list mentions the seas of W. and N.W. Australia as included in the range of the bird. The following quotation from Mathews' "Birds of Australia," vol. ii., p. 282, suggests that no other specimen of this bird from Western

PLATE I.

THREE-QUARTERS NATURAL SIZE.