OSTEOLOGY OF THE PENGUINS.

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(PLATE XXXVIII.)

IN my provisional classification of the group or class AVES, the Penguins occupy the following place in the scheme, viz.:—

Supersuborder III.:—APTENODYTIFORMES.
Suborder:—IMPENNES.
Family:—*Spheniscidæ*.

The literature of the anatomy of Penguins has been enriched from time to time by some very excellent papers and memoirs. Not a few of these have been examined by me, but more especially the one on "The Spheniscidæ," by Professor Morrison Watson (*Zoology*, Voy. 'Challenger,' pt. xviii.); the one by Dr. Coues, entitled "Material for a Monograph of the Spheniscidæ" (*Proc. Ac. Nat. Sci. Phila.*, 1872, pp. 170–212); and the article "Penguin," by Professor Newton, in his *Dictionary of Birds* (pt. 3, p. 705). Other worthy contributions to the subject are by MM. Paul Gervais and Alix (*Jour. de Zool.*, 1877, pp. 424–470); M. Filhol (*Bull. Soc. Philomath.* ser. 7, vi., pp. 226–248); and particularly the one by Professor Alphonse Milne-Edwards in the *Annales des Sciences Naturelles*, 1880 (vol. ix. art. 9, pp. 23–81). I have also read the paper by Dr Sclater upon *A. forsteri* and *A. pennanti* (*Ibis*, 1888, pp. 325–334), where figures of the skulls and sterna of those species are given.

As material, I have before me fine skeletons of *Aptenodytes pennantii*, *Spheniscus demersus*, and others, all belonging to the collections of the U.S. National Museum. These I have thoroughly studied and compared with all the available literature upon the subject, and have become convinced not only of the low morphological rank of the *Impennes*, as contrasted with other *Ornithuræ*, but of the marked difficulty that attends the deciphering the affinities of this extremely old and decidedly isolated suborder of birds.

In his scheme of the classification of birds, Fürbringer awards them a suborder, and places them between two other suborders, the first containing the Petrels, and the last the *Ichthyornithiformes*; in other words, between the *Tubinares* and the extinct cretaceous ichthyonine birds.

Steineger has said: "Little is known as yet as to the geological history of the penguins, except that it dates back to the upper eocene at least, since fossil bones (humerus, coracoids, and metatarsus) of a gigantic form, *Palœeudyptes antarcticus*, have been found in strata of that age in New Zealand. This form stood from six to seven feet high, or higher than an average man! We have here a distinct evidence of the great age of the group, as might also be inferred from their remoteness from all other known birds. Their relations seem to be with the other schizognathous Natatores, rather than with any other, but the exact affinities are very obscure."

In a footnote to the article "Penguin" in his *Dictionary of Birds* (p. 704), Professor Newton has said: "Though I cannot wholly agree with Professor Watson's conclusions, his remarks (pp. 230–232) on the 'Origin of the Penguins' are worthy of all attention. He considers that they are the surviving members of a group that branched off early from the primitive 'avian' stem, but that at the time of their separation the stem had diverged so far from reptiles as to possess true wings, though the metatarsal bones had not lost their distinctness and become fused into the single bone so characteristic of existing birds. The ancestral Penguins, he argues, must have had functional wings, the muscles of which, through atrophy, have been converted into non-contractile tendinous bands, and this view agrees practically with that taken by Professor Fürbringer and Dr Gadow."

There remains but one family of Penguins in existence, so far as known,—the *Spheniscidæ* (or *Aptenodytidæ*). To indicate their low morphological rank and their great age in geological times in a tabular or linear scheme of classification, I place them after the supersuborder *Odontoholceæ*. In doing this, however, their extreme isolation as an aquatic group of birds must be borne in mind.

There are at least four good genera of Penguins known, and

it is not likely that many others will be added to them. These genera are *Aptenodytes*, *Eudyptes*, *Pygosceles*, and *Spheniscus*.

The work done by Professor Watson is so excellent and so thorough that it leaves but very little to be said in the premises; what he did, too, is based upon more ample material than I have at my command at the present time, so that the most to be set forth in this work are the main impennine osteological characters which these birds exhibit, and which define the group as a distinct suborder, as well as indicate, in so far as their osteology is concerned, upon what the single family *Spheniscidæ* is based.

The Skull.—Although possessing a number of characters in common, the skulls of these four genera named above are strikingly different, showing a far greater difference, indeed, than do the skulls of the representatives of different families, as they have been defined for other avian groups. But Penguins possess many very extraordinary characters *in common*, which characters are not found in other birds; and when this is the case, little regard is paid to the variance among the skulls, and the forms are commonly restricted to one family, with a few genera.

In *Aptenodytes* the superior mandible is very long, narrow, and tapering, being gently decurved distally. The sutures of the elongated nasal bones are easily traced, and the proximal ends of the nasal processes of the intermaxillaries are free and distinct. Long and narrow, either narial opening extends far towards the mandibular apex. Upon the under side of this beak there is a long mesial vacuity extending from the base of the vomer behind to a point forwards opposite the anterior terminations of the narial apertures. In *Spheniscus* the superior osseous mandible is thick, and more or less massive like the rest of the skull of this Penguin. It is in length but a little longer than the cranium proper, and its apex is sub-abruptly deflected. From side to side, it is more or less compressed anteriorly, while all traces of the various sutures of the nasal bones are obliterated in the adult. Viewing the cranium upon its superior aspect, we find it flattened, and but moderately rounded off at the sides. The fronto-interorbital space is never very wide, and the large, superorbital glandular fossæ are always conspicuously developed. Posteriorly, in all Penguins the 'cerebellar prom-

inence' is well developed, and raised as a vertically elongated dome on the brain-case proper. Most peculiar is the occipital crest or ridge; it being not especially well defined in *Aptenodytes*, though strong enough to bound the occipital area. In *Spheniscus* so remarkably deep are the *crotaphite fossæ* at the sides of the cranium, that not only the occipital crests stand out as free laminæ of bone, but the aforesaid crotaphite fossæ even appear to undermine the very plane of bone that in most birds constitutes the occipital area itself, and this is continuous with the cristal portion. As pointed out by Watson, the basis of these free laminæ of bone in Penguins like *Spheniscus* are found on the line dividing the brain-casket from the cerebellar prominence, but in *Aptenodytes*, where the crotaphite fossæ are quite inconspicuous and very shallow, the occipital ridges are found away from the cerebellar prominence, and, as in many other water-birds, occur upon the cranium proper. At the lateral aspect of the skull the post-frontal processes are powerfully developed, and point directly downwards, while, upon either one, the superorbital glandular depression terminates upon the upper side. Less prominent is the squamosal process, though it is amply evident enough to bound the valley running between it and the post-frontal apophysis.

A very large vacuity occupies the posterior two-thirds of the *interorbital septum* in *Aptenodytes*; it is smaller in *Spheniscus demersus*; and, usually, still smaller in some other species of this genus, as *S. minor*. Considerable variation is seen in the *lacrymal bones* of Penguins, for in *Aptenodytes* the superior portion of one of these comes in contact with the *under side* of the nasal, as well as with the outer *lateral* edge of the same bone, and the frontal consequently can be well seen upon superior aspect of the skull. Now, in *Spheniscus demersus* this articulation is upon the nether aspect of the naso-frontal bones entirely, and thus conceals the lacrymal when the skull is looked at upon *direct* superior aspect.

The middle portion of a lacrymal is more or less contracted, but it spreads out again below, in order to make, in all the genera, an articulation upon the upper side of the zygoma. In *S. demersus* the central portion of either lacrymal is pierced by a large foramen, while in *Aptenodytes* this is absent, and the

bone is carried forwards and inwards as a process. *Spheniscus minor* and *mendiculus* also have the foramen, and its anterior margin may exhibit a slight apophysial protrusion.

Penguins have large *orbital cavities*, and this is particularly the case in *Aptenodytes*, where, however, the walls are not especially complete, except below, the floor being formed by the very wide palatine and greatly flattened out pterygoid upon either side. Owing in part to this unusual size of the orbit in *A. pennantii* the zygoma is decidedly arched in order to accommodate itself to the circularity of the cavity; from quadrate to lacrymal bone, the bar makes a low, curving sweep, the concavity, of course, being upon its upper side. This curve of the zygoma is likewise enjoyed in a similar degree by the ramus of the mandible, while this condition is scarcely at all noticeable, either in the case of the zygoma or mandible, in *Spheniscus demersus*, nor in other species of the same genus.

The *quadrate bone* is well developed in all Penguins, it having a double mastoidal head with a distinct antero-posterior groove dividing the facets; a triangular laterally-compressed orbital process (smallest in *Eudyptes*); a deep, capacious, and anteriorly notched cup for the quadrato-jugal; and a large, transversely placed facet for the mandibular articulation. This last is also separated into two facets by a middle groove, and the free end of the orbital process is truncated, and finished off with a bony nib. Many interesting characters are to be found upon the basal aspect of the skull in any species of the *Spheniscidæ*. The subcircular foramen magnum is remarkably large, and the condyle, likewise of pretty good proportions, is sessile. In front of this the basi-temporal area is smooth and flat, it being surrounded by a raised margin in front, and by the conspicuous paroccipitals at the sides. These anterior bony boundaries are best marked in *Spheniscus* and *Eudyptes*. Either *pterygoid* is much spread out; flattened completely from above downwards, and more or less triangular in form,—an isosceles triangle in fact, with its base to the front (when *in situ*), and with the inner basal angle articulating with the hinder end of the palatine of the same side and with the sphenoidal rostrum. In *Aptenodytes pennantii*, the pterygoid is less evidently triangular; its base is largely in contact with the border of the palatine

behind; and there may be a minute foramen in front. The hinder moieties of the *palatine* bones are very broad and parallelogrammatic in outline, their mesial and inner margins being nearly parallel to each other. Passing forwards, they gradually rise and contract, to merge finally anteriorly with the intermaxillaries; the sutural traces of the articulations being plainly evident in *Aptenodytes* (and in *Pygosceles*, Watson), but entirely obliterated in *Eudyptes* and *Spheniscus*.

The *vomer* is profoundly cleft posteriorly, the long slender limbs being weakly coalesced with the palatines; in front it is a free, vertical lamina of bone, sharp at the apex, and projecting without contact into the inter-maxillo-palatine space. Either maxillo-palatine is of a subcancellous structure, elongated and narrow, directed backwards as a free process. This much for *Aptenodytes*, while in *Spheniscus demersus* the osseous structure is far more compact, and the form of either maxillo-palatine more lamellar.

There are no *basi-pterygoid processes*, and the *basi-sphenoidal rostrum* is flat upon its under side; narrow, rounded off in front in *A. pennantii*, but in *Eudyptes* extended on as a small pointed spine.

One of *the* features in the skulls of Penguins is the difference in the curving of the 'infraorbital bar,' and of this Watson has said: "In respect of the form and curvature of the zygomatic arch, the skulls of *Pygosceles* and of *Aptenodytes* agree with that of *Eudyptes*, and differ from that of *Spheniscus*." This fact is again referred to here, as the form assumed by the *mandible* in the several genera varies, and is so peculiar that it offers another very good diagnostic character for them.

In *Aptenodytes*, the depth vertically of either ramus from junction of middle and posterior third, gradually tapers away to the mandibular apex. In *Pygosceles* the middle third of either ramus is evidently deeper than it is elsewhere; this is still better marked in *Spheniscus*, and reaches its maximum, where it is conspicuously pronounced, in *Eudyptes chrysocome*, and still more so in *E. chrysolophus*. Upon the whole, the lower jaw is V-shaped, with a very small, weak symphysis in all the short-billed Penguins, and not much improved in this particular in the long-billed ones. It is composed of the usual elements found in the mandibles of birds generally, and often the sutural

traces among these are very distinct at the middle third of the bone. Here they are so arranged as to give rise to a long slit-like vacuity in *Aptenodytes*, which is closed-in in *Spheniscus* and *Eudypytes*. My specimen of the last named is from the Falkland Islands. Professor Watson had before him one from the same locality, in which he found the ramal vacuity open. In all the species of the species and specimens of Penguins that I have examined, there is another ramal foramen, however, that is constantly present; it is small, oval in outline, and found at the middle of the posterior third of either limb of the jaw. Both the internal and posterior angular processes of the mandible is strongly developed in *Spheniscus demersus*; less so in *Eudyptes*; while in *Aptenodytes pennantii*, the posterior processes is scarcely noticeable. According to Watson, in *Pygosceles* "the posterior angular process is relatively less prominent than in *Aptenodytes*." Doubtless, *A. longirostris* is here referred to, and the statement is true; but I find them practically absent in *A. pennantii*, and, what is peculiar, moderately well developed in *Spheniscus minor*. A coracoid process seems to be universally absent among these birds.

The osseous skeleton of the tongue or the *hyoid bones* of several species of Penguin are at hand. In a very perfect 'hyoid' of *Spheniscus demersus*, one is struck with the resemblance it has for the common fowl (*Gallus bankiva*). In fact, all the elements are practically identical. The glosso-hyal is in cartilage; the cerato-hyals are but partially ossified; while the strong basi-branchials are fused into one piece; the posterior one being tipped with cartilage, and the anterior part of first basi-branchial articulating in the usual manner with the cartilaginous glosso-hyal. The conspicuously upturned epi-branchials are separated upon either limb from the longer, straighter, and stouter cerato-branchials by a cartilaginous interval, which Watson says is present in all Penguins examined by him.

As a whole, the skull is very slightly pneumatic in *Spheniscus* and *Eudyptes*, while *Aptenodytes pennantii* is better off in this particular.

Of the remainder of the Axial Skeleton.—This part of the osseous system in Penguins is, as indeed is all the rest of their bony structure, powerfully developed.

For the *vertebral column*, we find all the bones of the cervical and dorsal regions freely movable upon one another; those of the pelvic sacrum fuse most solidly into one piece, and to this the pelvic bones proper do not coösify as solidly as they do in many other birds; the skeleton of the tail is greatly elongated, and finished off with a pygostyle of very unusual length. In the *cervical series* there are invariably 15 vertebræ in all Penguins known to me. The 13th of these often has the pleurapophyses showing faint rib sutures; on the 14th a pair of free ribs is always found; and those on the 15th invariably possess *articulated* epipleural appendages. A very remarkable character is seen in the transverse processes of the 13th and 14th vertebræ, for these are elongated, and curl dorsad in a very striking manner, especially in *Aptenodytes pennantii* and *Spheniscus demersus*.

The carotid arches are always open, and commonly commencing with the 6th vertebræ, pass to include the 9th or 10th. Apparently non-pneumatic, these cervical vertebræ are short and wide, with conspicuously developed processes; complete lateral canals (3rd to 13th included); and when articulated *in situ*, form in all the species a pronounced double sigmoid curve thus  .

For the *dorsal region*, the vertebræ are articulated with each other in a way to insure the greatest amount of strength consistent with the maximum degree of mobility, while in all the species the neural and hæmal spines, as well as the transverse processes, are uncommonly broad and strong.

There are *six* dorsal vertebræ in *Aptenodytes*, *Spheniscus*, and *Eudyptes*, or in all the genera I have examined, and some of these may be opisthocœlous in character. They each and all support long, rather slender, true *vertebral ribs*, that connect with the sternum by long, slender, sweeping and curved costal ribs, after the manner of certain Auks. The *epipleural appendages* are large, flat, and elongated, and *articulate* with the ribs to which they belong. The last pair have them only in a rudimentary form in *Spheniscus minor* and *S. demersus*, but they are present upon that pair in *A. pennantii*, in which species

the epipleural processes in mid-series are of great size, with paddle-shaped ends. There is one pair of long, sweeping, *pelvic ribs*, but their hæmapophyses do not quite reach the costal border of the sternum upon either side. In *Aptenodytes pennantii* there is also a pair of 'floating costal ribs,' articulating with a pair of floating vertebral ribs, that are represented simply by short, rod-like pieces.

Among Penguins, the *pelvis* exhibits a very considerable amount of variation. It is long and narrow in *Aptenodytes*, and relatively shorter and broader in *Spheniscus*, while in *Eudyptes chrysocome* and in *E. pachyrhynchus* it seems to hold an intermediate place in this respect. In all the pre-acetabular portion of either *ilium* is a *thin*, plate-like, narrowish lamina of bone, that simply rests upon the sacrum, and rarely co-ossifies completely with it, even in old birds. The inner iliac margins in this region nowhere near approach the sacral crista, and the anterior iliac margins may be once or twice notched,—*twice* profoundly notched in a pelvis of *Eudyptes pachyrhynchus* at my hand (No. 17,840 U.S. Nat. Mus.); while the pre-acetabular part of an ilium is placed horizontally, its post-acetabular part lies in directly the opposite plane, or is *vertically* situated. The acetabular region itself is more or less massive; the anti-trochanter not very large, but the cotyloid ring distinctly so. In *E. chrysocome* the cotyloid ring is nearly double the size of the ischiac foramen, and the proportion is even greater in *Aptenodytes*, but in *Spheniscus demersus* the ischiac foramen is nearly four times as big as the acetabular ring. In all Penguins examined by me the postero-ilio-ischiac notch is well marked, and the elliptical obturator foramen is continuous with the long obturator space. The long blade-like pubic bone is not in contact with the ischium above it, and rarely projects much beyond the pelvis behind. In *Spheniscus* and *Aptenodytes* it is both paddle-shaped and decurved posteriorly, but this is not the case in *Eudyptes*. This last-named genus has the upper margin of the pubis nearly parallel to the lower margin of the ischium above it, and the space dividing the two bones exceedingly narrow, especially in *E. chrysocome*, but the two elements do not come in contact with each other.

Seven free vertebræ are found in the skeleton of the tail of

the Spheniscidæ, and the long, narrow *pygostyle* is made of nine more.[1]

In the caudal vertebræ the transverse processes are more or less aborted, while the neural spines and hæmal ones are often conspicuously developed. In *Spheniscus demersus* these spines are bifid, and the hæmal spines are found only upon the last two or three vertebræ.

According to Professor Watson, the number of vertebræ in the spinal column never exceed 43 (*Spheniscus demersus*, *S. magellanicus*, and *S. mendiculus*), while in the majority of the species there are but 42.

In the skeleton of *Eudyptes chrysocome* we find the type of the *sternum* as it usually occurs in this family of birds. Here the bone is of an oblong form, well concaved upon its dorsal aspect, while ventrad, a strong keel runs nearly its entire length, and projects out considerably in front, especially in *Aptenodytes pennantii*.

Posteriorly, the xiphoidal portion of the sternum shows upon either side an elongated notch of nearly uniform width. The lateral processes thus formed curve towards the middle line as they pass backwards, and are longer than the sternal body. The mid-xiphoidal process is of considerable width and size, and frequently is perforated by foramina. (These do not occur in all Penguins, and in *E. pachyrhynchus* they are so large that they are sometimes incomplete, thus forming notches.) The *ventral* margins of the costal borders are much raised and sharp, thus forming marked depressions for the pectoral muscles. Distinctly quadrilateral in outline, the costal processes are strong and thick, and are directed forwards and outwards. The anterior border between them is transverse, with a much aborted manubrium in the middle line (a process much better developed in *S. demersus*).

The 'costal grooves' are deep and of uniform width, each terminating, laterally, in a distinct pitlet.

According to Watson, "the articular depressions of the reception of the sternal ribs are six in number on either side in every species, with the single exception of *Pygosceles tæniatus*, in which, in accordance with the fact that seven ribs articulate

[1] According to Gervais and Alix in *Ostéologie et Myologie des Manchots*.

with the breast bone, there are seven distinct depressions on the lateral margin of the sternum."

"In *Pygosceles*, moreover, the relative lengths of the middle and external xiphoid processes exceed the middle process in length, while in *Pygosceles* the central xiphoid process equals or even exceeds that of the external processes" (*Report on the Spheniscidæ*, pp. 22, 23).

In *Spheniscus demersus* the costal process is perforated by a large foramen.

Penguins have a *scapula* of a most unusual form, it being thin and blade-like, besides being endowed with extraordinary width and length. It varies somewhat in outline in the different species; and in *Spheniscus demersus*, where the blade of the scapula is larger than the keel of the sternum, it may exhibit one or two elliptical foramina near its distal tip, usually, however, in full-grown birds, only in the bone of one side or the other. Both head and neck of the scapula is considerably flattened from above downwards, and in *S. minor* the anterior moiety of the bone has not more than one-third the width that the greatly expanded hinder portion has.

Watson gives us many figures and measurements of the sterna and scapulæ of the Penguins, and concludes by saying, "In short, with regard to the scapulæ, as to the sternum, there are two extremes, represented by the genera *Aptenodytes* and *Pygosceles*, and two means, represented by the genera *Eudyptes* and *Spheniscus*" (*ibid.*, p. 26).

As in the case of the scapula, the *os furcula*, varies in form somewhat in the different genera, but it is a good strong bone in them all. *Aptenodytes* has it of a somewhat elongated U-pattern; rather weak below, and devoid of hypocleidium, but becoming progressively stouter as it nears the coraco-scapular articulations above. These clavicular limbs are much compressed from side to side, and are each drawn out into a point after passing the coracoid articulation when the bones are *in situ*. Either clavicular limb develops an outstanding abutment, with facet for articulation with the produced head of the corresponding coracoid, while its distal apex articulates with the antero-internal angle of the head of the scapula.

All Penguins have the *coracoids* of great size and strength.

Taking the bone in *Aptenodytes pennantii*, for example, I find it to be considerably longer than the humerus of the same individual, and altogether a bigger and stronger bone. Its sternal end is not conspicuously expanded, while upon the whole a gradual tapering is seen to occur from this end towards the summit, accompanied by an antero-posterior flattening. On the inner side of the shaft an extensive wing-like process is thrown out, extending downwards for some distance from the scapular process. This is highly developed in *Eudyptes*, in which genus it is perforated by a large elliptical foramen, and which, due to absorption, is in *Aptenodytes* converted into a great notch. In *Eudyptes chrysocome* the dorsal end of the coracoid is produced considerably above this part of the bone, and supports at its summit the rather weak head of the bone, having here the form of a mesio-anteriorly produced process or hook. This species has the sternal end of the coracoid thick and strong, being convex transversely in front, and correspondingly concave behind, where its surface is roughened for muscular attachment.

At the inner angle of its sternal end there is an abruptly upturned process, that is quite characteristic of the coracoid in not a few of the *Spheniscidæ*.

Of the Pectoral Extremity.—Wing-modification has been carried to the extreme in Penguins, the limb having more the appearance of a 'flipper' or paddle of a sea-turtle than the wing of a bird. With this modification has followed an extraordinary compression of all the bones. As a rule, they are flat and oblong, and, apart from size, are characteristically alike in all the species. This flattening of the bones, in the case of the forearm and hand, is in a plane parallel to the plane of the keel of the sternum; while the humerus has received it in a plane nearly at right angles to this. This last-named bone is, as is the case with the skeleton of the entire limb, entirely non-pneumatic, although there is a wonderfully deep and circumscribed pneumatic fossa.

Every known species of Penguin has two large *sesamoids* at the elbow. They occur in life in the insertional tendon of the triceps muscles.

More or less oblong in outline, the *radius* and *ulna* have

sharpened outer edges; have their articular extremities simply modified in accordance with the aforesaid flattening of the limb; and, in life, are separated from each other by a narrow interosseous space, the bones in *Aptenodytes*, for example, being nearly of the same length and width.

Two *carpal bones* are present as usual in *Aves*; the *radiale* being an irregular nodule presenting the necessary facets of articulation for the joint; while the *ulnare* not only accomplishes this, but is likewise produced backwards as a large, flat, free, triangular process, characteristic of the skeleton of the wing of all Penguins.

In the flattened *carpo-metacarpus*, complete fusion has taken place between the first and second metacarpal, and that to such an extent as to almost (quite in *S. minor*) mask its very existence. The third metacarpal is a characterless, flat rod of bone fused by its extremities to the oblong and far broader second metacarpal. There are two joints to the last-named element, and a big, greatly elongated phalanx for the last finger on the ulnar side, it being even longer than the proximal joint of the second digit. Pollex digit has shared the same fate as the first metacarpal, and its presence would not be suspected in the adult bird.

Of the Pelvic Limb.—As in the case with the bones of the wings, the skeleton of this extremity in the Spheniscidæ is entirely non-pneumatic. Its *femur* and *tibio-tarsus* present the ordinary ornithic characters, while among the most striking peculiarities to be seen is the big *patella*.

Quite recently I had the pleasure of examining the leg-bones and patella of the type specimen of *Aptenodytes pennantii* used by Coues in his paper on "Material for a Monograph of the Spheniscidæ" (*Proc. Acad. Nat. Sci. Phila.*, xxiv., 1872). I give you a life-size drawing of these bones from the right limb of this Penguin, showing the great quadrate patella slightly raised above its articulation with the tibia. In the same cut, A and B, are copies of different views of the patella of *Eudyptes chrysocome* by Professor Watson (Report on the *Spheniscidæ*; Rep. Scien. Results of Exp. Voyage of H.M.S. 'Challenger,' vol. vii., pl. vii. figs. 9 and 10, *Zoology*, 1883). Professor Watson tells us that "the patella is of exceptionally large size, and

presents a somewhat peculiar form in the Penguins. In form it resembles a wedge, the anterior or sharp margin of which is directed forwards, the base backwards towards the femur. The base of the wedge is broad, deeply concave, and adapted to the pulley-like surface of the lower end of the femur. The outer

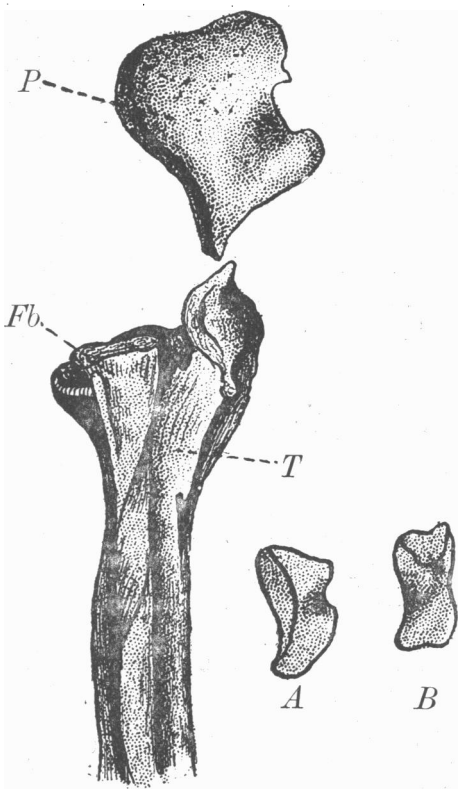


FIG. 1.—Leg-bones and patella, right limb of *Aptenodytes pennantii*; life-size from nature. T, tibia; F, fibula; P, patella; the last slightly raised above its articulation with tibia. (No. 11,976 Smithsonian Collection.) By the author. A, patella of *Eudyptes chrysocome* (from Tristan d'Acunha), outer surface, natural size. B, the same seen from in front (after Watson).

surface of the bone is for the most part smooth, but presents about its middle a deep and narrow groove, which, commencing in front at the middle of the anterior border of the bone, passes obliquely backwards, downwards, and outwards across the external surface. This groove accommodates the tendon of the

'ambiens' muscle. The inner surface of the bone is smooth. The upper end of the patella is obliquely truncated, and affords insertion to the muscular fibres of the extensor cruris muscle, while the lower end, narrower and more irregular in form, is attached by means of very short ligamentous fibres to the anterior border of the upper end of the tibia. The patella presents essentially the same characters in every species." This description answers very well for *Aptenodytes*, only this latter Penguin has the patella much larger, as will be seen in the figure. In the great majority of birds where a patella exists it is found to have the form of an oblate hemispheroid, with its base directed upwards for insertion of the extensor cruris.

Other characters are the long and stout *fibula*, and the remarkable skeleton of *pes*. In this latter the *tarso-metatarsus* is short, broad, and of an oblong outline, the three metatarsals composing it being more or less distinct, lying parallel to each other in the horizontal plane, being thoroughly fused together at their extremities. The *hallux* is greatly aborted in most species, and plays no important part in the foot of any of the Penguins.

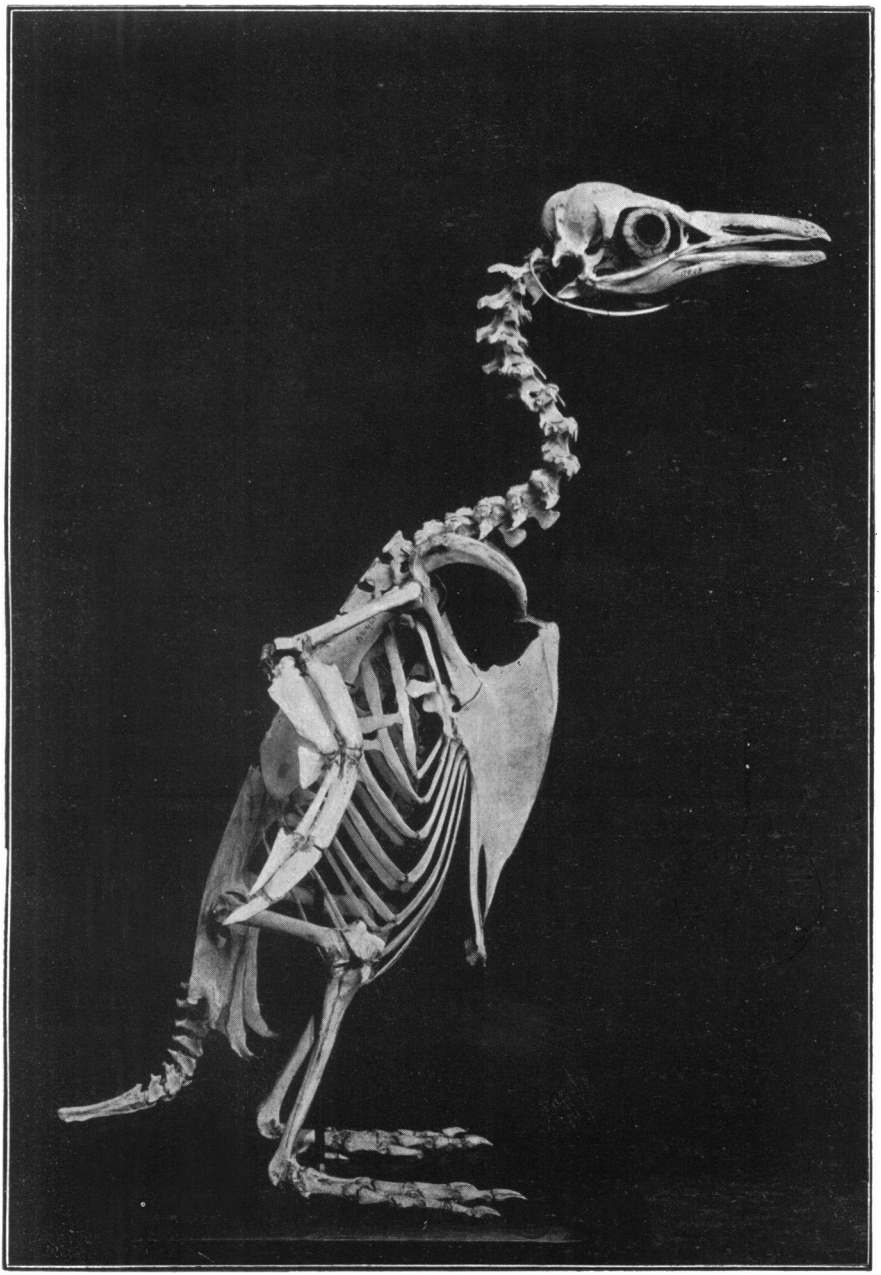
The phalangeal formula of the joints is normal, and the three anterior toes are cylindrical in form, with closely locked articulations, and terminate with strong, little-curved claws. This part of the skeleton of the foot has a very reptilian aspect; and I find in *Aptenodytes pennantii* three smallish *sesamoids* in its sole, and others still smaller under the podal digits at their bases.

The characters of the scapulæ, the skeleton of the pectoral limbs, the patellæ, and the feet exhibited on the part of the Penguins are not to be found in any other existing group of birds, and it would seem are alone sufficient to warrant us in placing these remarkable pelagic forms in a suborder of birds by themselves. This, as already stated above, has accordingly been done.

EXPLANATION OF PLATE XXXVIII.

Right lateral view of the skeleton *Spheniscus demersus*.

Considerably reduced. From a photograph of the specimen in the collection of the U.S. National Museum at Washington (No. 17,938). Specimen collected at Angra Pequena, South Africa.



SPHENISCUS DEMERSUS.

DR SHUFELDT.