VIII. *On the Axial Skeleton of the Pelecanidæ.* *By* St. George Mivart, *F.R.S., F.Z.S., Professor of Biology at University College, Kensington.*

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[Plates LV. to LXI.]

In selecting the above-named group as the one to succeed that the axial skeleton of which formed the subject of a previous communication to this Society[1], I have thought it well to take *Pelecanus* as my type and standard of comparison, first comparing it, as regards its axial skeleton, with *Struthio* and the other Struthionidæ, and then comparing the other *Steganopodes* with it and with one another.

The osteology of *Pelecanus* was very briefly described by Mr. Eyton in his 'Osteologia Avium,' p. 219, with a figure of the entire skeleton (pl. 7L), and with figures of the pelvis and sternum (pl. 38. no. 2). It has been described with more detail by Brandt, with figures of the entire skeleton, of the sternum, and pelvis (table vii.), in the 'Mém. de l'Acad. Imp. des Sc. de St.-Pétersbourg,' 1840, 6th series, Sciences Mathématiques, Physiques et Naturelles, tome v. seconde partie, Sciences Naturelles, tome iii. p. 141.

PELECANUS.

The materials I have been able to make use of for the examination of this genus are:—

The mounted specimen, No. 1167, of *P. onocratalus*, disarticulated skeletons Nos. 1168 B and 1168 C, and a sternum, all in the collection of the Royal College of Surgeons.

A disarticulated skeleton of *P. rufescens*, lent me by the kindness of Professor Garrod, F.R.S.

A mounted skeleton of *P. mitratus*, No. 70. 3. 30. 1; another of *P. onocratalus*, No. 527A; two other mounted skeletons unnamed, Nos. 64. 12. 20. 1 and 67. 7. 8. 4 respectively; and a disarticulated skeleton, No. 65. 5. 3. 12,—all in the British Museum.

The total number of vertebræ in this species seems generally to be 42, without counting the pygostyle[2].

[1] Read on the 17th of November, 1874. See *antè*, p. 1.

[2] In *P. mitratus* in the British Museum there are but 40 vertebræ in all, there being but 3 lumbar and 5 caudal. In Nos. 67. 7. 8. 4. and 527A there are but 41 vertebræ, there being but 3 sacro-caudals.

These vertebræ may be subdivided as follows—16 cervical, 1 cervico-dorsal[1], 5 dorsal, 4 lumbar, 3 lumbo-sacral[2], 3 sacral, 4 sacro-caudal[3], and 6 caudal, besides the pygostyle.

The whole axial skeleton is exceedingly pneumatic, each vertebra being very light, and having a swollen appearance with smooth surfaces and ridges, and processes but little developed. Hyperapophyses and metapophyses are small; and only three or four vertebræ have conspicuous hypapophyses.

Besides the cervical vertebræ, the two following ones are also generally movable.

The rest of the dorsal vertebræ and the lumbar vertebræ have their bodies ankylosed together, and somewhat compressed laterally, but not remarkably so.

The Cervical Vertebræ.

The cervical vertebræ unite so as to form angles with one another, open ventrad till the seventh's junction with the eighth, which forms an angle open dorsad, as does that of the eighth with the ninth, and so postaxiad till they unite without forming an angle at all.

The atlas, compared with that of *Struthio*, is narrower transversely in proportion to its antero-posterior extent (Plate LV. figs. 1 & 2).

Viewed *preaxially*, the dorsum of the neural arch is more visible, because its preaxial part is more inclined ventrad. The odontoid notch is relatively deeper, and has the minute secondary notch on the middle of its dorsal margin more marked. The dorsal ends of the preaxial articular surface are produced more preaxiad, and rise dorsad slightly above the level of the outward process, which they embrace. There is no diapophysis.

Postaxially, the ventral surface of the neural arch is more visible for the reason above given; the odontoid notch is deeper; and the articular surface of centrum is more curved, but scarcely at all produced preaxially on the neural surface of the centrum.

Ventrally, there are either no *catapophyses* (or lateral *hypapophysial* processes), or they are quite minute, while the median hypapophysis is less produced postaxiad relatively than in *Struthio*.

Viewed *laterally*, the preaxial margin of the pedicel of the neural arch is very slightly concave, while its postaxial margin is almost as concave as in *Struthio*. There are no hyperapophyses; and the zygapophyses are very small and inconspicuous.

The preaxial margin of the centrum is more concave than in *Struthio*, on account of the greater production preaxiad of the dorsal parts of the preaxial central articular surface.

Seen *dorsally*, the *postaxial* margin of the neural arch is less concave than in *Struthio*, on account of the less postaxiad production of the zygapophyses.

The pedicels of the neural arch are very slender.

The axis is inclined more dorsad postaxially upon the atlas than in *Struthio*; it is

[1] With movable ribs which do not reach the sternum, and with no lateral vertebral canal.

[2] The pelvic vertebræ without parapophyses.

[3] Postsacral vertebræ forming part of pelvic mass. Sometimes there are but three of these.

also antero-posteriorly shorter, and dorso-ventrally longer, not only than in *Struthio*, but even than in *Dromæus*, if we omit from consideration the hypapophysis of the axis of the latter (Plate LV. fig. 3).

The *odontoid process* is smaller relatively than in *Struthio*.

Viewed *preaxially*, the articular surface of the centrum is more concave, and its ventral margin more convex.

Postaxially, the articular surface of the centrum looks less dorsad and more directly postaxiad. The transverse extent of its ventral margin considerably exceeds that of its dorsal margin. The hypapophysis is continued more ventrad than in *Struthio*.

Ventrally, there may or may not be two ridges diverging postaxiad from near the preaxial margin of the ventral surface of the centrum.

Laterally, the neural spine extends more dorsad than in *Struthio*, like that of *Dromæus*, but is longer antero-posteriorly than in the latter genus. The neural arch extends much more postaxiad than in *Struthio*, so that one third of its whole antero-posterior extent is postaxial to the postaxial end of the centrum.

The *hypapophysis* extends more ventrad; its preaxial margin is concave or concavo-convex, and inclined gently ventrad and postaxiad; its postaxial margin is almost in a line with the postaxial margin (as seen laterally) of centrum.

There is a small pleurapophysial lamella (at preaxial third of side of centrum) enclosing the lateral vertebral canal, the small preaxial aperture of which is visible when the axis is viewed laterally; there is a slight interzygapophysial ridge, which may be perforated; but there is no transverse process.

Seen *dorsally*, more of the neural surface of the centrum is visible than in *Struthio*, owing to more of the preaxial part of the neural arch having been, as it were, obliquely cut off. The præzygapophyses are very small; but the postzygapophyses are nearly as large, relatively, as in *Struthio*. Each is concave from without inwards, convex antero-posteriorly; and they look ventrad and slightly externad.

The hyperapophyses (*hp*) are small and inconspicuous.

The postaxial margin of the neural arch is slightly concave; its preaxial margin is more concave, but without any median projection preaxiad.

The THIRD VERTEBRA is much larger and half as long again as the axis. Its neural spine is less high; its neural arch is medianly notched postaxially; and the much elongated bony lamella enclosing the lateral canal is laterally prominent, and is evidently the first appearance of a transverse process. It bears, postaxiad, a rudimentary styloid process. It differs from that of *Struthio* in the greater extent of its antero-posterior dimension compared with its transverse diameter (Plate LV. fig. 4).

Preaxially, the central articular surface is hardly to be seen, since it looks almost entirely ventrad.

Ventrally, a hypapophysis may be seen projecting ventrad and postaxiad at the postaxial end of centrum; but it may be flattened on its ventral surface so as to present two lateral

marginal ridges, and sometimes also a median one in addition. The preaxial articular surface of centrum is plainly visible, while immediately postaxial to it is a fossa deeper, relatively, than in *Struthio*. Catapophyses begin to appear; but conspicuous on each side is the postaxially projecting short parapophysial styloid rib-like process.

Seen *laterally*, the bony lamella enclosing the lateral vertebral canal extends through the preaxial half of vertebra, while, as before said, a rudimentary styliform parapophysial process projects postaxiad from the ventral end of its postaxial margin. This pleurapophysial lamella is not continued back to reach the postzygapophysis, though a faintly marked ridge extends so far.

The neural arch does not extend postaxiad beyond the centrum nearly so much as in the axis, but more than in the third vertebra of *Struthio* or *Dromœus*.

Hyperapophyses plainly exist; and metapophyses may be distinguished. The neural spine is much less developed than in the axis.

Viewed *dorsally*, the lateral margins of the vertebræ are more concave than in *Struthio*. The præzygapophyses are convex and very elongated, and look preaxiad, mesiad, and dorsad.

The postzygapophyses oval, look externad and ventrad, are concave transversely, and slightly convex antero-posteriorly.

The third vertebra unites with the axis at a sharp angle, and one which opens in an opposite direction to the angle formed by the junction of the axis with the atlas.

The preaxial end of the canal for the vertebral artery opens beside the preaxial articular surface of centrum and beneath the præzygapophysis.

The FOURTH VERTEBRA is a little larger in most dimensions than the third. It differs from the latter much as that of *Struthio* differs from its third; but the hypapophysis has more completely disappeared, and the neural arch more nearly approaches the preaxial end of the centrum. The free portion of the styliform parapophysial rib is not longer than is that of the third vertebra. There is not so much difference as to the squareness of outline of the bone when viewed dorsally (and compared with the third vertebra) as in *Struthio*, the fourth vertebra being, indeed, more antero-posteriorly elongated than the third, but not being relatively so much more elongated in proportion to its transverse breadth.

The lateral vertebral canal is much less spacious, relatively, than in *Struthio* or *Dromœus*; and the styliform rib is much less, relatively, extended. The postaxial margin of the neural arch is also less concave.

The preaxial articular surface of the centrum occupies less of the ventral surface of the bone; the catapophyses are rather more marked, and the hyperapophyses are rather less marked than in the third vertebra.

The neural spine is longer and lower; and, instead of any hypapophysis, the ventral surface of the centrum is very slightly grooved medianly throughout.

No process extends postaxially from the postaxial margin of the pleurapophysial lamella.

The FIFTH VERTEBRA differs as much from the fourth as the corresponding one of *Struthio* differs from its serial predecessor, except that the preaxial margin of the neural arch is not more concave, and that there is no noteworthy difference as to the development of the metapophyses.

In addition to these points, in which it differs like the fifth of *Struthio* from its predecessor, it also differs from the fourth vertebra in that the whole ventral surface of the centrum is deeply channelled medianly and antero-posteriorly, two parallel ridges running postaxially from the two catapophyses (Plate LV. fig. 5).

The lateral vertebral canal is of about the same length as in the fourth vertebra; and therefore the part of the vertebra postaxial to it is slightly longer. The hyperapophyses are developed to about the same degree as in the fourth vertebra; and the styliform rib is not longer. Both this vertebra and the first differ from the corresponding vertebræ of *Struthio* and *Dromæus* in that the postaxial margin of the neural arch is not nearly so concave, and that the neural spine is not excavated either pre- or postaxially. The increase in length of this vertebra over the fourth is less than in *Struthio*; it unites with its serial predecessor at a very obtuse angle.

A conspicuous foramen opens on each side of the ventral surface of the centrum, just behind the catapophysis; it leads into the lateral vertebral canal.

When the vertebra is viewed ventrally a wide shallow median groove is seen, bordered on each side by a continuous catapophysial ridge. Outside the anterior third of each catapophysial ridge is an antero-posterior (fig. 5, *g*) groove separating this ridge from the postaxially extending parapophysial rib-like process.

The SIXTH VERTEBRA (Plate LV. figs. 6, 7, 8) closely resembles the fifth, and is of nearly the same size. It differs from the fifth as does that of *Struthio* from its predecessor, except that, when viewed dorsally, the neural surface of the centrum is not more exposed at the preaxial end of the vertebra, and that catapophyses do not here begin, but only increase a little in size. The subcentral antero-posterior groove is deeper and more strongly bordered. At its preaxial end the catapophysial antero-posterior ridges project mesiad (fig. 8, *c*), and draw inward (as it were) somewhat the parapophysial styloid processes, which are here less developed than in the fifth vertebra, and are separated from the catapophyses by a shorter, though still very conspicuous, antero-posterior groove (fig. 8, *g*). The hyperapophyses are hardly smaller.

The præzygapophyses project preaxiad of the centrum to a greater rather than a less degree than in the fifth vertebra; and the pre- and postaxial margins of the neural arch are not more concave.

This vertebra differs from the fifth in the still greater production ventrad of the lateral margins of the subcentral antero-posterior groove, and in the somewhat more

lateral position, and sometimes in the smaller size, of the postcatapophysial subcentral foramen of each side (fig. 8, *f*).

Metapophyses and hyperapophyses are rather more marked; the præzygapophyses look rather more preaxiad; and the postzygapophyses look slightly more externad.

The postaxial part of the centrum extends more ventrad than in the fifth vertebra, so that, when laterally viewed, the vertebra appears bent ventrad postaxially.

The SEVENTH VERTEBRA about equals the sixth in size. Unlike that of *Struthio*, it does not differ from its serial predecessor as to the preaxiad development of the præzygapophyses, since these extend preaxially beyond the centrum and parapophyses as much as they do in the sixth vertebra, and the postzygapophyses project postaxially beyond the centrum much more than in the sixth vertebra. It also differs from the seventh vertebra of *Dromæus*, as well as from that of *Struthio*, in that the rib-like process is very much shorter, and the lateral vertebral canal is much less capacious—differences which all obtain in the preceding vertebræ (Plate LV. figs. 9–12).

The postaxial ends of the laminæ bounding the antero-posterior subcentral groove are more or less marked as processes.

Compared with the sixth vertebra, the seventh one has a rather more prominent neural spine; and this is confined to the antero-posterior middle third of the neural arch. It has also more marked catapophyses and a deeper subcentral groove. The postzygapophyses are longer and look more externad. The hyperapophyses are smaller and have advanced more preaxiad of the postaxial ends of the postzygapophyses.

There is a marked and sudden difference from the foregoing vertebræ in the appearance (when the vertebra is viewed dorsally) of a deeply concave postaxial margin of the neural arch. The pleurapophysial lamella is antero-posteriorly shorter; and thus the subcentral oval foramen of each side, leading into the vertebral-artery canal, appears close behind its postaxial margin, and can be seen when the vertebra is viewed laterally (fig. 9, *f*). There is no free rib-like process, or but a rudimentary one. The postaxial surface of the centrum looks almost entirely postaxiad, and very little dorsad.

The ventral margin of the postaxial surface of the centrum is more deeply notched than heretofore.

Viewed *laterally* this vertebra is seen to be bent ventrad postaxially, as is the sixth vertebra; but the more antero-posteriorly continuous development of the catapophysial ridges makes this less evident.

When this vertebra is viewed *ventrally* we see at the preaxial part of each catapophysial ridge two small antero-posterior grooves, the inner one of which (fig. 11, *c*, *g*) might be taken as corresponding with the apparently similar grooves of the sixth vertebra. Really, however, it is the outer groove (*g*) which does so, while the inner groove is very different, not being bordered externally (as in the sixth vertebra) by the parapophysis, but by the preaxial end of the catapophysial ridge, while it is bounded medianly by a prominence which has no place in the sixth vertebra, but which is in

series with the side of the median ventral prominence beneath the hæmal arch of more postaxial vertebræ. The parapophysial process of the seventh vertebra is much smaller and less conspicuous than in the sixth vertebra, and is a little antero-posterior ridge of bone outside the postero-ventral part of the pleurapophysial lamella.

Thus the ridges bounding the median subcentral groove in more postaxial vertebræ are catapophysial (*i. e.* lateral hypapophyses), the parapophysis hardly reappearing as a small distinct process till the fifteenth vertebra.

The diapophysis does not begin to appear as a more or less distinct, though small, postaxially projecting process till at the fourteenth vertebra.

When the seventh vertebra is viewed *dorsally*, the *hyperapophyses* are seen to have advanced somewhat preaxiad from the ends of the postzygapophyses, which extend much outwardly and postaxially beyond them.

The EIGHTH VERTEBRA, unlike the same vertebra in *Struthio* and *Dromæus*, presents very great differences from its preaxial predecessor. The latter differs strikingly from the sixth by the sudden appearance of a deep concavity at the postaxial margin of the neural arch between the long backwardly extending postzygapophyses; but in the eighth vertebra other and more remarkable characters suddenly appear, some of which are correlated with the backward extension of the postzygapophyses of the seventh vertebra (Plate LV. figs. 13–17).

The eighth vertebra is slightly shorter than the seventh, and very slightly shorter than the sixth, fifth, or even the fourth vertebra, though it is longer than the third.

When the eighth vertebra is viewed *dorsally* the neural surface of its centrum is more exposed than in the seventh vertebra through the oblique cutting away of the preaxial part of its neural arch, which arch is deeply concave postaxially, even more so than in the seventh vertebra (fig. 14).

The *preaxial articular surface of the centrum* (fig. 16) looks preaxiad and somewhat dorsad (instead of almost entirely ventrad, as in the preceding vertebra), is very much constricted medianly, while each lateral and expanded part is very convex dorso-ventrally, and very slightly indeed concave transversely. The preaxial opening of the vertebral lateral canal (*v*) opens above (dorsad) and postaxiad to this surface, instead of above and beside it as in the seventh vertebra; thus it is hardly seen when the vertebra is viewed preaxially, but is conspicuous when the vertebra is viewed dorsally—conditions precisely the reverse of those obtaining in the seventh vertebra.

The *postaxial* articular surface of centrum (fig. 17) expands more laterally ventrad than in the seventh vertebra; and the whole surface looks postaxiad and not dorsad. Viewed laterally the vertebra is seen to be less bent ventrad at its postaxial end than in the seventh vertebra, and the postaxial end of the catapophysial ridge, or plate (which bounds the subcentral groove externally), is more sharply defined as a process.

For the first time since the axis vertebra, the præzygapophyses are not carried pre-

axiad but dorsad, and fail to project preaxially as much as does the centrum. The articular surface of each præzygapophysis looks not only dorsad and mediad, but, for the first time of all, even slightly postaxiad; it is convex antero-posteriorly, with a hardly perceptible concavity transversely.

The postzygapophyses (*i. e.* the whole processes which support the articular surfaces, not alone those surfaces themselves) extend more directly postaxiad, and more postaxiad of the centrum than in the seventh vertebra. The articular surface is less broad in proportion to its length antero-posteriorly, and looks more externad and less ventrad than in the seventh vertebra. The neural spine is much less prominent.

The *metapophysis* (*m*) appears as a slight prominence outside the præzygapophysis.

Seen *dorsally* (fig. 14), a marked fossa is visible on each side postaxial to (and as it were continued on from) the præzygapophysis. These fossæ receive the postzygapophyses of the seventh vertebra when it is much bent back upon the eighth vertebra. The *hyperapophyses*, seen thus, also exhibit a singular change from their condition in more preaxial vertebræ. In the seventh vertebra (as before said) they have already left the ends of the postzygapophyses and advanced preaxiad; but here they extend forwards as two oblique ridges, approximating preaxially, and about as prominent as is the neural spine.

In *P. rufescens* they extend forwards over the postaxial two thirds of the neural arch.

In *P. onocratalus* they extend yet considerably more preaxiad, and form the lateral margins of the neural arch when this is dorsally viewed.

The pleurapophysial lamella is shorter antero-posteriorly than in the seventh vertebra; there is no styloid or distinct parapophysial process of any kind; and the oval subcentral foramen is more or less visible, when the vertebra is viewed laterally, postaxial to the postaxial margin of the pleurapophysial lamella.

The lateral vertebral canal runs very obliquely, and suddenly dorsad, as it extends preaxiad—in marked contrast to its course in the seventh vertebra.

When the vertebra is *viewed ventrally* the inner processes of the *catapophyses* are seen to have united to form a subcentral arch which hides between a quarter and a third of the ventral surface of the centrum. The preaxial margin of this arch exhibits a median notch with a convexity external to it on each side. Postaxially its margin is deeply concave. Its ventral surface exhibits a blunt, median, antero-posteriorly extending prominence with a concavity on each side of it, which concavity is serially homologous with the little antero-posteriorly extending groove on the ventral surface of the catapophysis of the seventh vertebra.

The lateral catapophysial margins of the median subcentral groove on the ventral surface of the centrum are still sharper and more prominent than in the seventh vertebra, so that the groove is somewhat deepened, and it is the dorsal part of the wall of this groove which is perforated just behind the catapophysial (or hypapophysial) bridge by the oval foramen just mentioned.

This vertebra unites with the seventh at a marked angle, but one which opens the reverse way from that in which the angle formed by the seventh with the sixth vertebra opens. The mode of flexion here initiated is repeated in the next articulation; so that the eighth vertebra has both its adjacent vertebræ bent up dorsad from it, whereas the third, fourth, fifth, and sixth vertebræ have each their two adjacent vertebræ bent down ventrad, while the seventh vertebra has its next preaxial vertebra bent down ventrad from it, and its next postaxial vertebra bent up dorsad from it.

The NINTH VERTEBRA (Plate LV. figs. 18–21) is very like the eighth, but slightly longer. The preaxial articular surface of the centrum is directed somewhat more dorsad and less preaxiad, and is a little more transversely extended. The preaxial openings of the canals for the vertebral artery are even more plainly visible when the vertebra is viewed dorsally (fig. 19). The articular surfaces of the præzygapophyses are directed more mediad; and the processes supporting these surfaces are seen to extend postaxiad as well as dorsad when the vertebra is viewed laterally. The constriction (laterally) of the neural arch by the fossæ just postaxiad of the præzygapophyses is more marked. The hyperapophyses are similarly but more developed. The preaxial margin of the hæmal (catapophysial) arch extends as much preaxiad as does any part of the centrum.

The plates bounding laterally the median subcentral groove do not end in such distinct processes, the ventral margin postaxiad of each such process sloping more obliquely to reach the postaxial end of the centrum.

The TENTH VERTEBRA is like the ninth, but slightly longer. The hyperapophyses are less marked, except at their postaxial ends. The neural spine stops short of the postaxial end of the neural arch. The postzygapophyses look more externad. The hæmal arch is more antero-posteriorly extended, and the grooves on its ventral surface are wider and deeper. The margins of the subcentral median channel subside gradually postaxiad without there being any longer a noticeable process.

The ELEVENTH VERTEBRA, compared with the same vertebra in *Struthio* and *Dromæus*, presents striking differences. Thus the preaxial surface of the centrum looks dorsad instead of ventrad, and its postaxial surface looks postaxiad instead of partly dorsad. The præzygapophysial surfaces are differently directed, and are less long, relatively, than in *Struthio*; though not than in *Dromæus*. There are no styliform rib processes; but there is a hæmal arch and subcentral channel.

The whole vertebra is not so long a bone, in proportion to its other dimensions, as in *Struthio*; but it is longer relatively than in *Dromæus*.

This vertebra is like the tenth of *Pelecanus*, save that it is stouter, though not longer. Its postaxial articular surface expands less ventrad. Its præzygapophysial surfaces lie more open, *i. e.* look rather more dorsad. The hyperapophyses are less strongly marked; and the neural arch is more flattened dorsally. The plates bounding the subcentral channel laterally, subside still more postaxially. The præzygapophyses (*i. e.* the processes supporting the articular surfaces) extend more dorsad and less post-

axiad. The postzygapophyses scarcely extend postaxiad to the postaxial end of the centrum; and their articular surfaces look more externad than in the tenth vertebra. The preaxial margin of the hæmal arch may extend a little preaxiad of the preaxial end of centrum.

The TWELFTH VERTEBRA is a little shorter and stouter than the eleventh. The flattened neural arch is seen to expand more postaxiad when viewed dorsally; but its postaxial margin is somewhat less concave.

The hæmal arch and its ventral grooves are wider; and the arch itself does not extend preaxiad beyond the preaxial end of the centrum. Both the præ- and postzygapophysial surfaces are somewhat broader. The former look more dorsad, and the latter slightly more externad.

For the first time in the whole vertebral column yet examined, the postzygapophyses fail to extend postaxiad as far as the postaxial end of the centrum.

The THIRTEENTH VERTEBRA is shorter and more massive, proportionally, than its predecessor, and wider transversely (like the sixteenth vertebra of *Struthio*). The fossa behind the præzygapophysis (which has been getting less marked since the ninth vertebra) has almost disappeared. Seen *dorsally* the vertebra appears more hourglass-shaped; the neural spine begins to rise again; and a concavity begins to appear behind its postaxial end; and the hyperapophyses are merely slightly marked ridges diverging from the postaxial end of the neural spine. The hæmal arch broadens, and its ventral grooves widen (Plate LV. figs. 22–24).

The præzygapophyses incline again slightly preaxiad and extend preaxially as far as the centrum and even a little further.

The FOURTEENTH VERTEBRA repeats and carries further the characteristics of the preceding vertebra.

Especially marked is the lateral expansion of both præ- and postzygapophyses; and now the transverse extent of the vertebra in the situation of the former begins greatly to exceed its transverse extent as measured across the postzygapophyses. The neural spine is more elevated. From the dorsal end of the postaxial margin of the pleurapophysial lamella a small inconspicuous process projects postaxiad. This is the representative of the *diapophysis*.

Sometimes the hæmal arch is medianly cleft, so that there seem to be two, lamellar, closely approximating catapophyses. The canal for the vertebral artery is greatly enlarged.

The FIFTEENTH VERTEBRA exhibits very marked changes when compared with the fourteenth (it thus corresponding with the eighteenth vertebra of *Struthio*). It is rather shorter antero-posteriorly, rather wider transversely, with the width of its preaxial part greatly predominant. The pleurapophysial lamella sends back postaxiad a marked diapophysial process (*d*) from the postero-outer dorsal margin of the enormously expanded lateral vertebral canal, which has been gradually widening since the sixth

vertebra. On the postero-outer ventral margin of the pleuropophysial lamella is a small concave fossa. This is bounded in front by a minute tubercle, which is the reappearance of a parapophysial process, while mediad of and behind the concave surface is a slight ridge, which is the serial homologue of the catapophysial ridge of more preaxial vertebræ (Plate LV. figs. 25–29).

From the diapophysial process a ridge runs preaxiad along the dorsum of the pleurapophysial lamella, and slightly mesiad, ending preaxially in a marked antero-posterior metapophysial ridge, separated from the adjacent margin of the præzygapophysial surface by an antero-posterior shallow groove.

The hæmal arch has disappeared altogether, and in its place is a median hypapophysis, which bends strongly preaxiad beneath the preaxial end of the centrum. On each side of this is a wide groove, bounded externally by the parapophysial tubercle, fossa, and ridge above noticed.

The neural arch is not cut away obliquely; for its preaxial margin projects almost as much preaxiad as does the centrum.

The neural spine is higher than in the fourteenth vertebra; and the concave surface postaxiad of it is much reduced in extent.

Not only do the præzygapophyses again extend preaxiad (though only slightly so) of the centrum, but the postzygapophyses (for the first time since the tenth vertebra) extend considerably postaxiad of the postaxial end of the centrum.

The canal for the vertebral artery is still more capacious.

The preaxial articular surface of the centrum looks mainly ventrad (which it has not done since the seventh vertebra) instead of preaxiad; and the postaxial articular surface looks dorsad instead of postaxiad, in this respect returning to the condition of the tenth vertebra. Moreover this surface is less convex transversely than in the preceding vertebra, and its ventral margin is less concave.

The SIXTEENTH VERTEBRA exaggerates the characters already given of the fifteenth. The preaxial surface of the centrum is somewhat flattened out, less concave transversely. The ventral margin of the postaxial articular surface of the centrum is either very slightly concave or even slightly convex. All the zygapophysial surfaces are smaller. The præzygapophyses scarcely extend preaxiad of the centrum. The neural spine is higher, and is inclined over preaxially at the summit of its preaxial end. Its postaxial fossa is still more reduced. The dorsum of the transverse process is more extensive, and it extends outwards further beyond the ridge, extending preaxiad and mesiad from the end of the diapophysial process to the metapophysis, which latter is more widely separated from the præzygapophysis.

The ventral enclosure of the lateral vertebral canal (*i. e.* the pleurapophysial lamella) is reduced to a delicate bridge of bone, very narrow antero-posteriorly. At the dorsal end of this bridge is a slightly marked and convex (articular?) surface.

The *hypapophysis* is much smaller than in the fifteenth vertebra, and springs from close to the preaxial margin of the centrum.

A slightly marked ridge runs postaxiad and externad from a point mesiad of the parapophysial root of the bony bridge above described. These lateral ventral ridges are the serial representatives of the catapophysial ridges of more preaxial vertebræ, and each ends postaxially in a small transverse process, which projects externad on a line just postaxiad to the whole. For the first time since the fourth vertebra, we here find the postzygapophyses extending postaxiad decidedly, though very little, beyond their articular surfaces.

The Cervico-dorsal Vertebra.

The SEVENTEENTH VERTEBRA again exaggerates the character of its serial predecessor. The whole vertebra is antero-posteriorly shorter, and in fact somewhat smaller in nearly all dimensions; but the transverse processes and metapophyses (seen dorsally) are much as in the sixteenth vertebra. The zygapophyses are a little smaller. The neural spine is antero-posteriorly extended at its tip, whilst its postaxial fossa is so postaxial that it is invisible when viewed dorsally. The neural spine broadens out postaxially, exhibiting, dorsally, a median ridge and two lateral ones diverging from a common point postaxiad.

The hyperapophyses project as two little pointed processes, one above each postzygapophysis. The preaxial articular surface of the centrum widens out still more, and looks entirely preaxiad, or only very slightly indeed ventrad. The postaxial central surface looks postaxiad.

The hypapophysis is smaller, and the ridges on each side of its root fainter.

There is no lateral vertebral canal. Such a canal is inclosed only by the help of the rib; and to support this there are two distinct articular facets—a parapophysial one a little postaxiad of the lateral margin of the preaxial articular surface of the centrum, and another diapophysial one beneath the postaxial end of the antero-posterior ridge of the transverse process.

The præzygapophyses do not project so far preaxiad as does the centrum.

The seventeenth vertebra is in one line with the eighteenth.

The Dorsal Vertebræ.

The EIGHTEENTH VERTEBRA is slightly smaller than the seventeenth. The preaxial surface of the centrum is less wide transversely; the same is the case with its postaxial surface, which is also not at all concave at its ventral margin. The hypapophysis is rudimentary and has no ridges on each side of its root. The transverse process is somewhat less produced postaxially. The neural spine and its postaxial fossa are both smaller. The præzygapophyses fall still further short of attaining the preaxial end of the centrum, while the postzygapophyses extend rather less postaxially beyond the

postaxial end of the centrum than in the seventeenth vertebra. There are similar par- and diapophysial surfaces, but further apart.

Defects of ossification, which began to appear in the preceding vertebra between these surfaces, on the outsides of the transverse processes, are here very conspicuous; and sometimes a large oval foramen (placed between the postzygapophysis and the adjacent postaxial margin of the transverse process) leads into the substance of the hæmal arch on each side.

The NINETEENTH VERTEBRA is the first vertebra which forms, in the adult, part of the sacral mass, being more or less ankylosed to the vertebra next succeeding. It is slightly smaller, in all dimensions, than is the eighteenth vertebra; but the lateral defect of ossification is much larger and is *the* conspicuous lateral opening, the postaxial intervertebral foramen being much smaller than that between the eighteenth and nineteenth vertebræ.

The TWENTIETH and TWENTY-FIRST VERTEBRÆ repeat the characters of the nineteenth, except that they are slightly smaller and more and more involved in the preaxiad extension of the iliac ossification, which completely covers the dorsum of the twenty-first vertebra, except that a foramen opens (dorsally to the transverse process), extending obliquely preaxiad and dorsad.

The rib-surfaces are rather less far apart in the twenty-first than in the twentieth vertebra; in the latter they are at their maximum of separation.

The TWENTY-SECOND VERTEBRA is still smaller, and is overlapped by the ilium itself. The di- and parapophysial surfaces are much more approximated. The defects of ossification are less extensive, though there is much individual variation in this respect.

The dorsal end of the transverse process sends out postaxially an arched ossification (concave ventrally) which meets a similar but preaxially extending arched process from the preaxial end of the dorsal part of the transverse process of the twenty-third vertebra. Thus, when these vertebræ are viewed laterally, there is the appearance of a bony arch extending up dorsally between and connecting them (Plate LIX. figs. 1 & 3, XXII).

THE LUMBAR VERTEBRÆ.

In comparing these vertebræ with the so-called lumbar vertebræ of *Struthio*, and with the corresponding vertebræ of most of the other Struthionidæ, a striking difference is apparent. It consists in the marked differentiation which exists in *Pelecanus* between those more preaxial lumbar vertebræ which send out parapophysial transverse processes, and those more postaxial ones which only develop ascending diapophysial processes, and thus leave a wide interval between their vertebral centre and the acetabula—*i. e.* a *lateral acetabular* or *renal* fossa on each side, as will be more fully noticed in describing the ventral aspect of the pelvis.

These vertebræ, therefore, are more evidently divisible into true *lumbar* vertebræ and

lumbo-sacral vertebræ than is the case in any of the Struthionidæ, except *Apteryx* and *Dinornis*. There are three or four[1] true lumbar vertebræ.

The TWENTY-THIRD VERTEBRA (or first true lumbar) resembles its serial predecessor, except that there are no costal articular surfaces, but the transverse process is smooth on its ventral surface, and the centrum is more flattened ventrally.

The arch formed by the junction between the postaxially extended and dorsally curved parapophysial transverse process of this vertebræ, and the similarly curved, but preaxially extended, parapophysial transverse process of the twenty-fourth vertebra has here become a presacral foramen.

The TWENTY-FOURTH VERTEBRA is similar to the last described; but the centrum is smaller, and the parapophysial transverse process more expanded and flattened ventrally. Its presacral foramen is smaller.

The TWENTY-FIFTH VERTEBRA is almost quite similar to the twenty-fourth.

The TWENTY-SIXTH VERTEBRA differs from the last in having its transverse process free postaxially, and not uniting with any parapophysis of the twenty-seventh vertebra. The postaxial margin of the transverse process forms the most ventral portion of the preaxial margin of the great lateral acetabular fossa. The diapophysis ascends obliquely dorsad and slightly externad to the ilium, and is generally quite distinct from the parapophysis.

The intervertebral foramen is medianly constricted antero-posteriorly so as to approximate to two superimposed foramina.

The Lumbo-sacral Vertebræ.

These vertebræ are three in number—namely, the TWENTY-SEVENTH, TWENTY-EIGHTH, and TWENTY-NINTH.

These three intimately united vertebræ have the ventral surfaces of their centra narrowing postaxiad and concave transversely, thus forming a continuous plate, antero-posteriorly grooved (Plate LIX. fig. 3).

Their diapophyses ascend almost directly dorsad, the two more posterior on each side (viz. those of the twenty-eighth and twenty-ninth vertebræ) being visible through the acetabula when the pelvis is viewed laterally (Plate LIX. fig. 2).

There are no parapophyses, or only minute rudiments of such. The intervertebral foramen behind each vertebra is more or less median, constricted antero-posteriorly.

The Sacral Vertebræ.

There are three sacral vertebræ—the THIRTIETH, THIRTY-FIRST, and THIRTY-SECOND; and they form a series, the centra of which decrease in size postaxially, and continue on

[1] Only in the specimens of *P. mitratus*, No. 70. 3. 30. 1, in the British Museum, have I found this number reduced to three.

(though much narrowed transversely) the subcentral antero-posterior groove of the lumbo-sacral vertebræ (Plate LIX. fig. 3).

In these three vertebræ the parapophyses become again suddenly and greatly developed (especially those of the first sacral vertebra), abutting moreover against the ilium. The three parapophyses of each side are united together distally.

The diapophyses of these vertebræ take origin at a higher and higher level (*i. e.*, more and more dorsad) as we proceed postaxially, so that in the thirty-second vertebra they simply diverge from the lateral margin of the summit of the neural arch.

The coalesced neural spines of these and of the lumbo-sacral vertebræ form a rounded antero-posterior prominence, convex transversely, running along the middle of the dorsum of the pelvis (Plate LIX. fig. 1).

The Sacro-caudal Vertebræ.

These are generally four; but there may be only three[1] of these vertebræ. They are differentiated from those of the last category by the non-union serially and distally of their parapophyses together, or with the diapophyses of the sacral vertebræ.

The THIRTY-THIRD, THIRTY-FOURTH, THIRTY-FIFTH, and THIRTY-SIXTH VERTEBRÆ form a series decreasing in size postaxiad, each provided with a parapophysial process (on each side), which ascends postaxiad and dorsad to the ilium (Plate LIX. fig. 3).

The diapophyses proceed externad from the dorsum of the neural lamina, while the neural spines are ankylosed together antero-posteriorly as before. A foramen is thus formed (apparent on the dorsum of the pelvis) between each serial pair of diapophyses.

As we proceed postaxially, however, the diapophyses spring successively from a lower (less dorsad) level as regards the neural spines; so that generally in the last sacro-caudal they have again completely coalesced with the parapophyses; and thus the antero-posteriorly extended canal between the diapophysial and parapophysial elements, which has hitherto existed right through the vertebral column from the axis inclusive, here ends and is finally closed.

The Caudal Vertebræ.

These vertebræ may be five[2] or six in number (more generally six) apart from the terminal pygostyle (Plate LIX. fig. 6).

[1] As in the specimens Nos. 527 A and 67. 7. 8. 4 in the British Museum.

[2] I have only found five in the specimen lent me by Professor Garrod, and in a skeleton of *P. mitratus* (No. 70. 3. 30. 1) in the British Museum. Thus in this individual (with but three lumbar vertebræ) there are but forty vertebræ in all, apart from the pygostyle. In the specimens with only three sacro-caudals, there were six free caudals, therefore forty-one vertebræ in all, apart from the pygostyle.

The THIRTY-SEVENTH VERTEBRA[1] has its neural arch provided with a pair of small præzygapophyses for articulation with corresponding and similar postzygapophysial processes extending from the neural arch of the last sacro-caudal vertebra.

It has a small neural spine and transverse processes inclined slightly ventrad; and each transverse process bears a more or less marked pit or depression on its preaxial surface, indicating a distinction between its diapophysial and parapophysial elements. There is no hypapophysis.

The THIRTY-EIGHTH VERTEBRA is similar to its predecessor, except that its zygapophysial processes are a little longer, and also its transverse processes.

The THIRTY-NINTH VERTEBRA is like the thirty-eighth; but its transverse processes are slightly longer.

The FORTIETH VERTEBRA has slight postzygapophysial processes to its neural arch as well as præzygapophysial ones. It has also generally a small preaxially extended hypapophysis at the preaxial margin of its centrum. This process may be medianly divided, however (as in No. 70. 3. 30. 1. in the British Museum), or may be wanting although there are six caudal vertebræ and four sacro-caudals (as in No. 64. 2. 20. 1. in the British Museum). The transverse process is thicker, but not quite so extended laterally as in the preceding vertebra.

The FORTY-FIRST VERTEBRA.—This is like the last; but the neural spine is not quite so dorsally extended; the transverse processes are shorter, more swollen, and more antero-posteriorly extended; the hypapophysis is much larger and bifold, being medianly grooved on its ventral aspect.

The FORTY-SECOND VERTEBRA is smaller in all dimensions, except that its hypapophysis is still larger than in the vertebra last noticed, and is curved strongly preaxiad as well as ventrad.

The PYGOSTYLE consists doubtless of many vertebræ united; but it plainly consists (even in the adult) of the vertebræ ankylosed together. The whole structure forms a plate antero-posteriorly and dorso-ventrally extended, but thin transversely. Its dorsal margin is convex, its preaxial one concave and irregular; its ventral margin is strongly convex for the preaxial three fourths of its extent, and strongly concave for the rest; it meets the dorsal margin at its postaxial end, so that the whole plate ends postaxially in a strongly curved pointed process, extending postaxiad and ventrad.

The dorsal part of the plate is, of course, formed of coalesced neurapophyses, and its ventral part of coalesced hypapophyses. There is a more or less marked antero-posteriorly extended ridge on each side, formed of coalesced transverse processes. Often two superimposed foramina (one dorsal, the other ventral of the lateral ridge), mark off a small anterior part as the ultimate visible vertebra from the much larger

[1] This is, of course, the thirty-sixth when there are but three sacro-caudals.

and terminal portion of the pygostyle. This most anterior portion represents, more or less completely, at its preaxial end the characters of the forty-second vertebra.

The Pelvis.

The pelvis of the adult consists of fifteen or sixteen vertebræ with the ossa innominata. Compared with that of *Struthio* and the other Struthionidæ it presents many contrasts (Plate LIX. figs. 1–3).

Preaxially viewed, the ilia form a much less steep arch (approximate dorsad at a more obtuse angle) than in any of the Struthionidæ (than even in *Dromæus*); and the ilium, thus seen, is concave on each side. It differs from *Struthio* and *Rhea* in that the pubis and ischia respectively simply diverge ventrad.

Postaxially viewed, it differs from the pelvis of all the Struthionidæ in the wide (transversely extended) and dorsally flattened postaxial ends of the ilia; the ilia not being laterally compressed and flattened against the sides of the vertebræ included between their most postaxial parts.

Laterally viewed, the acetabula are seen to be a little preaxiad of the antero-posterior middle of the pelvis, measured from the preaxial end of the ilium to the postaxial end of the pubis. The pelvis differs from that of all the Struthionidæ in that (1) the ilium (*il*) is less vertically expanded in front of the acetabulum, (2) that it is relatively more vertically expanded behind the acetabulum, (3) that the ischium (*i*) is, at its distal end, largely united with the ischium. Moreover the ischium extends postaxially beyond the ilium more than in any of the Struthionidæ, except *Struthio* and *Rhea*, but about as much as in *Struthio*, though not nearly so much so as in *Rhea*.

The pubis (*p*) extends postaxiad of the ischium much more than in any of the Struthionidæ, except *Struthio*, which is so exceptional in its family in this respect. The pubis is curved as in *Struthio*, but scarcely ever approximates at its tip to its fellow of the opposite side. The obturator-foramen is long and narrow, and shaped much as in *Struthio*, except that its anterior part is not divided off, that division being here only indicated by a rudimentary intertrochanteric process of the ischium, which does not nearly attain the pubis (Plate LIX. fig. 2, *ps*).

In this respect *Pelecanus* differs from all the Struthionidæ, except *Apteryx* and *Dinornis*. The pubis has no opposite corresponding process, or a mere rudiment of such.

There is no ilio-pectineal process, by which *Pelecanus* differs from all the existing Struthionidæ, if not from *Dinornis* also.

No process extends ventrad from the mid ventral margin of the pubis.

The antero-posterior diameter of the pelvis is rather more than twice its dorso-ventral dimension.

There is an oval sacro-sciatic foramen. There is no such foramen in any of the Struthionidæ, except in *Rhea* and sometimes in *Casuarius*.

Dorsally viewed (Plate LIX. fig. 1), the ilia are not relatively so transversely expanded preaxiad as in any of the Struthionidæ, and the lateral preacetabular margins of the ilia are not so concave.

The antitrochanteric process (*at*) is situated just preaxiad of the antero-posterior middle of the pelvis. It stands out a little less sharply than in any of the Struthionidæ, because the lateral margin of the pelvis postaxiad of it is not so concave as it is in all that family.

The postacetabular part (*il'*) is much broader than in any of the Struthionidæ. It is widely flattened dorsally, with a median antero-posterior ridge, and a series of foramina on each side of it.

The outline of the postaxial end of the pelvis differs widely from that of any of the Struthionidæ. Its general outline is deeply concave. Moreover the postaxial margin of the ischium (which forms part of the general postaxial outline) is also deeply concave, and therefore unlike that of any of the Struthionidæ.

The pubis extends postaxiad more than in any genus of the last-named family which has not got a pubic symphysis.

The greatest transverse diameter of the pelvis is between almost the hindermost parts of the ischia.

The transverse diameter between the trochanteric processes widely exceeds that of any more preaxiad part of the pelvis, in which respect it differs from the pelvis of any existing Struthious bird.

Ventrally viewed (Plate LIX. fig. 3), the pelvis of *Pelecanus* differs strikingly from those of all the living Struthionidæ in the relatively great and absolutely predominating width of its postacetabular part, also in the conspicuous *lateral acetabular* or *renal fossæ* on each side, mesiad of the acetabulum (*f*).

In these two points it agrees with *Dinornis*, though even in *Dinornis* the renal fossæ are much smaller, relatively, than in *Pelecanus*, and are subcrescentic in form (each crescent being convex mesiad), while in *Pelecanus* each fossa is subquadrate in shape, by which it differs absolutely from all the Struthionidæ. It also differs from them in that there is a deep, though small, fossa (the *supraacetabular* fossa) on the ventral surface of each ilium, just external to the expanded conjoined ends of the parapophyses of the sacral vertebræ (fig. 3, *f'*); only the innermost part of it is to be seen in a direct ventral view. This fossa deepens at its preaxial end, and terminates preaxially by a foramen which leads into a distinct fossa on the ventral surface of the postaxial external part of the roof of the acetabulum. This *supraacetabular fossa* is marked off by a strong ridge on its internal side.

By the presence of these fossæ and foramina *Pelecanus* differs from all the Struthionidæ.

The ventral surface of the vertebral part of the pelvis is widest at the last lumbar vertebra, then slowly contracts postaxiad to the third caudal.

The parapophyses of the lumbar vertebræ form together three presacral foramina on each side (fig. 3, s^1, s^2, s^3). Postaxiad of this there are no parapophyses, but the wide as well as long (though somewhat longer than wide) subquadrate renal fossa appears on each side.

The parapophyses of the three sacral vertebræ become shorter postaxially.

Those of the sacro-caudal vertebræ remain of about the same transverse extent as those of the third sacral vertebra.

There is no fossa on the ventral surface of the ilium towards its postaxial end, any more than there is in any of the Struthionidæ; but there is a wide surface (posterior iliac ventral surface) of ilium extending outwards on each side between the distal ends of the sacro-caudal parapophyses and the outer margin of the ilium (fig. 3, *il'*).

The Ilium.

This bone almost extends to roof over the last dorsal vertebra but one (*i. e.* the twenty-first vertebra); an ossification of fascia connected with it continues onto two or three vertebræ more preaxial.

Seen laterally, the preacetabular part has its dorsal margin very slightly convex; its ventral margin is concave in even a less degree than the other is convex. The two margins meet together preaxially. There is no ilio-pectineal process.

The ilium probably takes about the same share in forming the acetabulum that it takes in *Struthio*.

The postacetabular part of the ilium decidedly exceeds in length its preacetabular part. Seen laterally this part is at first very small (*i. e.* above the sacro-sciatic foramen), but more postaxially it expands dorso-ventrally to join the ischium.

Seen dorsally this part is widest just behind the antitrochanteric process, whence it narrows postaxially to the hinder end of the sacro-sciatic foramen, and then expands to join the ischium.

The postaxial end of the ilium develops a large ilio-caudal process (*lc*), which is separated from the sacrum by a narrow notch, and from the postaxial end of the ischium by a much wider notch.

There is a gluteal ridge (fig. 1, *gl*) extending along the dorsal edge of the ilium from the preaxial end back to the antitrochanteric process. Just behind and above this process is a small prominence (figs. 1 & 2, *st*), which may be compared to the supratrochanteric process of the Struthionidæ, and may be here termed the *posttrochanteric* process. The ilium has on its ventral surface the supraacetabular fossa before described.

The Pubis.

This bone is long and very narrow, with a sigmoid curvature, but without any prominent process. It forms no ankylosis with any other bone postaxial to its origin. It widens (dorso-ventrally) just postaxiad to its ligamentous attachment to the ischium.

In shape it remarkably resembles the most posterior ribs; so that, were we guided by its appearance in this animal alone, the pubis would certainly be reckoned as a pleuropophysis.

The Ischium.

This is the shortest of the three bones forming each os innominatum.

It expands preaxially to form part of the acetabulum, then remains narrow to its antero-posterior middle, and then expands dorso-ventrally to join the ilium. It does not ankylose with the pubis postaxially, unless perhaps it may do so in aged individuals.

Its outer surface postaxiad of the ventral part of the acetabulum presents a smooth groove, bounded ventrally at its preaxial end by a slight process (figs. 2 & 3, *ps*) projecting preaxiad and somewhat ventrad. This process is really the preaxial end of the ventral margin of the ischium; and mesiad of the margin is a long antero-posteriorly directed groove (fig. 3, *g*), bounded internally (*i. e.* mesiad) by a rounded antero-posteriorly directed prominence, which runs on preaxially to the junction of the ischium with the pubis beneath the antero-posterior middle of the acetabulum. Postaxially this ridge runs on to the postaxial extremity of the bone. Such a groove exists in *Casuarius* alone amongst the Struthionidæ.

The ischium extends about as postaxiad as does the ilium, but much less so than does the pubis.

The Ribs.

There are eleven ribs on each side in all—namely, six vertebral ribs, and five sternal ones.

The Vertebral Ribs.

The first vertebral rib, that of the cervico-dorsal vertebra, or seventeenth vertebra, ends freely distad, but proximally it is provided with a distinct tuberculum and capitulum. Compared with the apparently corresponding rib of *Struthio*, the capitulum is much longer and the tuberculum is much shorter. The pneumatic foramen (which is double) is situated more ventrad. There is a large unciform process, which is longer than the length of the rib distal to it.

The second vertebral rib, or the *first true rib* (*i. e.* the first which is connected by a sternal rib with the sternum), has again a much shorter tuberculum than in *Struthio*. The unciform process is a little more dorsad in position, so that the part of the rib ventral to it is larger than it. The rib is rather more flattened than is its serial predecessor, and more bent convex preaxiad; and its dorsal end is wider. It is a more slender bone, relatively as well as absolutely, than in *Struthio*.

The third vertebral rib has again a very short tuberculum. The unciform process is more dorsad than in the first true rib. The tuberculum and capitulum are wider apart, and the whole bone is antero-posteriorly wider, than is the case in the second rib.

In the fourth vertebral rib the tuberculum and capitulum are not so wide apart as

in the second true rib. The unciform process is smaller and more dorsad. This bone is very nearly of the same length as are the two ribs preaxial to it.

The fifth vertebral rib has its tuberculum still shorter and its unciform process smaller and more dorsad, if it is not entirely absent. This bone is not quite so curved as is the one preceding.

The *last*, or sixth, vertebral rib has its tuberculum very small indeed, so that the proximal end of this rib is characteristically small. There is no unciform process; and the bone is flattened and very little curved.

The whole series of true ribs have at first (*i. e.* towards the preaxial end of the series) their main curvature situated more ventrally than at their more dorsal parts. Gradually as we proceed postaxiad the curvature becomes more dorsad; this is less marked in the last but one; and in the last there is one nearly equal curve throughout.

The true vertebral ribs are all nearly of equal length.

The Sternal Ribs.

These are five in number, and rapidly increase in length as we proceed postaxiad (Plate LIX. fig. 4).

The *first* (attached to the first true rib and eighteenth vertebra) has two minute distal articular surfaces.

The *second* is almost twice the length of the first, and has a postaxial pneumatic foramen; in shape it resembles its predecessor.

The *third* is about twice the length of the first.

The *fourth* is not quite twice the length of the second. It is much curved, and may be considerably flattened and expanded dorsally.

The *fifth* sternal rib is more than twice the length of the second, but is not quite equal to the length of the second and third added together. It is more curved than its predecessor, and is always singularly expanded proximally, with a postaxial process simulating a blunt unciform process, which has, as it were, slipped down ventrad.

The Sternum.

The sternum differs, of course, from that of the Struthionidæ in being keeled. The keel is ankylosed to the clavicles, and extends much preaxiad of the preaxial end of the sternum proper. The keel subsides postaxially a little behind the middle of the sternum (Plate LIX. figs. 4 & 5).

The general surface of the sternum is more convex ventrally, and more concave dorsally, than in *Struthio*. It is proportionally narrower transversely, and antero-posteriorly longer.

The coracoid grooves (*c*) form together a right, if they do not even form a slightly acute angle. They are medianly separated. Their ventral and dorsal margins extend preaxiad about equally; but the dorsal margin is expanded and rounded towards its inner end

for articulation with the coracoid. In the middle of the preaxial end of the sternum a groove proceeds obliquely ventrad and preaxiad, and may end preaxially in a deep fossa.

The costal angles (*ca*) are much as in *Struthio*. The postaxial margin of the sternum has one median and two external xiphoid processes (*mx* & *lx*). There is no prominence in the wide, more or less deeply marked, concavity which extends on each side of the median xiphoid process.

Each lateral margin of the sternum is slightly concave.

The *pleurosteon* is not so wide dorso-ventrally as in *Struthio*. It bears five articular surfaces for the five sternal ribs. The fossæ between these surfaces are not nearly so deep as in *Struthio*; and each pair of superimposed articular surfaces are not so plainly convex, and not even relatively so much separated from one another.

If we eliminate the keel, then the sternum of *Pelecanus* is much like that of *Struthio*; but the angle made by its coracoid groove is most nearly approached by *Casuarius* of all the Struthionidæ. The concavity on the ventral surface of each costal angle is somewhat deeper than in *Struthio*.

SULA.

The skeleton of *Sula* is shortly described by Mr. Eyton in his 'Osteologia Avium,' p. 220, with the figure of the entire skeleton (pl. 6 L). Of this genus I have examined the following specimens:—a disarticulated skeleton in my own collection; a mounted specimen in the Museum of University College, Kensington; six specimens (1185, 1185 A, and 1186 A–D) in the Museum of the Royal College of Surgeons; and three specimens (Nos. 527 *b*, 731 *a*, and 779 *a*) in the British Museum.

The total number of vertebræ seems to be generally forty-three or forty-four, without counting the pygostyle.

These vertebræ are subdivisible as follows:—fifteen cervical, three cervico-dorsal, and six dorsal (the above numbers are constant in all the specimens examined); the lumbar vertebræ are generally three, but they may be two or four; the lumbo-sacral vertebræ are generally three, but they may be only two in number; there are one or two sacral vertebræ; the sacro-caudal and caudal vertebræ, taken together (and excluding the pygostyle), are generally twelve, but may, rarely, be as many as thirteen (of these the seven last are caudal).

The whole axial skeleton, when compared with that of *Pelecanus*, is of a more compact and dense texture, and less pneumatic. The various ridges and processes are thus sharper and more marked. The styloid rib-like processes are more conspicuous, being free and not merely forming part of the side of a subcentral groove.

Metapophyses are much more developed; but hyperapophyses are not so; while, except in the second, third, and fourth vertebræ, where they are much larger, median hypapophyses are still less developed and little more than rudiments, save in the seventeenth and eighteenth vertebræ.

Besides the cervical and cervico-dorsal vertebræ, the first two or three dorsal vertebræ are more or less movable; but the last dorsal ankyloses with all the more postaxial vertebræ to the end of the sacro-caudals; and the lumbar and last dorsal vertebræ have their centra more compressed laterally.

The cervical vertebræ unite, as in *Pelecanus*, so as to form angles with one another, open ventrad till the seventh's junction with the eighth, which forms an angle open dorsad, as does that of the eighth with the ninth, and so on postaxiad till they unite without forming an angle at all.

The Cervical Vertebræ.

These vertebræ, when compared with those of *Pelecanus*, present differences more or less analogous to the differences presented by those of *Casuarius* compared with those of *Struthio* and *Rhea*; for the vertebræ have become individually shorter antero-posteriorly, and at the same time more rugged and ridged, with relatively more prominent processes.

The ATLAS presents a small odontoid-foramen (*of*) instead of a notch. The neural arch is larger antero-posteriorly, with long postzygapophyses, generally making the postaxial margin of the neural arch more concave. The hypapophysis is decidedly more developed (Plate LVI. figs. 1 & 2).

The AXIS has its neural arch cut off still more obliquely preaxially; the hyperapophyses are very much more developed, and the hypapophysis enormously so: it projects ventrad and slightly, or much, postaxiad; and its summit has two small vertical grooves, bordered by one median and preaxial and two lateral ridges. Two minute processes project from near the preaxial end of the ventral surface, near its middle; and another projects above each on each side, being placed a little more dorsad as well as postaxiad (Plate LVI. fig. 3, *ps*).

The postaxial articular surface of the centrum has its dorsal margin even slightly longer than its ventral one.

There is no pleurapophysial lamella; but there is a conspicuous foramen on each side, leading into the substance of the bone, and situated at the ventral part of the strongly marked lateral fossa produced by the much stronger projection here than in *Pelecanus* of the interzygapophysial ridge (*iz*). The margin of the neural spine, viewed laterally, is less convex.

The whole neural arch hardly projects so much postaxiad of the centrum as in the genus first described.

The THIRD VERTEBRA is shorter than in *Pelecanus*, relatively as well as absolutely, being no longer than the axis; it is more concave laterally; the neural arch is more cut away preaxially. The hyperapophyses and hypapophysis very much longer, the latter having preaxially still three ridges and two vertical grooves towards its extremity. The lateral vertebral canal is much shorter, and very much more capacious, even absolutely.

The interzygapophysial ridge is very much more prominent; and the outline of the upper border of the neural arch is strongly concave. The præzygapophyses look more dorsad. There is a prominence outside the root of the rib-like styloid process (which latter is much longer relatively than in *Pelecanus*), separated from the rudimentary metapophysis (*m*) above it by an antero-posterior groove (Plate LVI. fig. 4).

The FOURTH VERTEBRA repeats the general characters of the third; but the rib-like process is longer, the metapophysis stronger, and the hypapophysis smaller (though still large), with only a single groove on its ventral surface.

The FIFTH VERTEBRA is like the fourth, but that the still plainly parapophysial rib-like process is slightly longer, and the metapophysis larger, with no groove on its ventral side (Plate LVI. fig. 5).

The hypapophysis has become replaced by a more or less narrow median subcentral groove, from the sides of the wide, more preaxial, part of which minute prominences indicate the commencement of catapophyses or lateral hypapophyses (*c*).

The SIXTH VERTEBRA (Plate LVI. figs. 6–8) is rather longer, has the hyperapophyses much more developed, the metapophyses more marked, and the subcentral groove wider. The underpart of centrum is very convex antero-posteriorly, the vertebra being, as it were, flexed dorsad at each end towards its ventral surface. The catapophyses are more marked than in the fifth vertebra; and the diverging rib-like styloid processes are still plainly parapophysial. The vacant space between these processes and the catapophysial ridges of the centrum corresponds with the groove between the catapophysis and the parapophysis on each side of the centrum of the sixth vertebra of *Pelecanus*.

The SEVENTH VERTEBRA presents similar differences to its predecessor from the seventh of *Pelecanus*, except that the postzygapophyses do not project more postaxiad, nor is the postaxial margin of the neural arch more concave. The hyperapophyses are advanced as in *Pelecanus*, but they generally form ridges diverging postaxiad from the summit of the neural spine. The styloid parapophysial processes and catapophyses are essentially similar to those of the sixth vertebra, but they are somewhat more approximated (Plate LVI. figs. 9–12).

The EIGHTH VERTEBRA in *Sula* (Plate LVI. figs. 13–17) contrasts with its predecessor even more than it does in *Pelecanus*, except that the neural arch is not cut away so much more preaxially, that there is not so much difference as to the preaxial opening of the lateral canal, nor in the shape and direction of the postaxial surface of centrum. The hyperapophyses also are less marked; and the catapophyses do not form a hæmal arch. On the other hand, the metapophyses are suddenly very much developed, presenting a rugged outstanding process, irregularly flattened behind, projecting dorsad and externad from the dorsal part of the outside of the pleurapophysial lamella, just external to the præzygapophysis.

The rib-like styloid processes are more slender, and closely approximated to the small catapophyses; and they have become so much more ventral and median in posi-

tion compared with those of the seventh vertebra that they may be regarded as being rather catapophysial than parapophysial. Thus a change takes place here, resembling that described as taking place in passing from the sixth to the seventh vertebra of *Pelecanus*.

The same contrasts takes place with its angles of articulation with adjacent vertebræ as in the eighth vertebra of *Pelecanus*.

The NINTH VERTEBRA, as in *Pelecanus*, exaggerates the characters of the eighth. Its preaxial part is still more, as it were, pressed backwards (postaxiad) and downwards (ventrad). In it, however, the hæmal arch is still generally incomplete[1]. The neural spine is a short strong process, higher and more marked than in the eighth vertebra. Each hyperapophysis appears as a short but strongly projecting process, a line from which to its fellow of the opposite side passes just behind the neural spine. The metapophyses are again more developed, and project sharply dorsad externally to the præzygapophyses; and each has two lateral and small prominences (tubercles) below it on the external margin of the process, which, as a whole, is concave postaxially with a median vertical ridge. Considerably ventrad of these tubercles is the small prominence of the parapophysis (*p*), separated by a narrow groove from the long styloid rib-like process, which is here plainly catapophysial, developing processes mesiad and preaxiad, which may sometimes[2] meet to form a hæmal arch, though this is not generally developed till in the next vertebra. Either this ninth vertebra, or else the next, has the largest styloid ribs (Plate LVI. figs. 18–21).

The TENTH VERTEBRA is like the eighth, except that all the processes are smaller—notably the neural spine and postzygapophyses. The metapophysis still bears the three tubercles on its external margin, and has the vertical ridge behind. There is a hæmal arch which is somewhat antero-posteriorly grooved medianly. The parapophyses are generally a little less marked than in the ninth vertebra (Plate LVI. figs. 22–24).

The ELEVENTH, TWELFTH, and THIRTEENTH VERTEBRÆ become slightly shorter successively. They present the general characters of those of *Pelecanus*, due allowance being made for the shortness of the bones. Here also, as in *Pelecanus*, the postzygapophyses fail in the twelfth vertebra for the first time in the whole vertebral column to attain the postaxial limit of the hinder end of the centrum.

The hæmal arch advances preaxiad more in front of the preaxial end of the centrum than in *Pelecanus*. The three lateral metapophysial tubercles are still conspicuous; but in the twelfth and thirteenth vertebræ the parapophyses have become undistinguishably united with the side of the rib-like styloid catapophysial process.

The FOURTEENTH VERTEBRA differs from that of *Pelecanus* in that the hæmal arch is suddenly and entirely wanting; and there is even no trace of a catapophysis, the postero-ventral prominence of the bony ring enclosing the lateral vertebral canal being purely parapophysial.

[1] Complete in 527 B in the British Museum.

[2] As, *e.g.*, in No. 779 A in the British Museum.

The FIFTEENTH VERTEBRA (Plate LVI. figs. 25–28) is like of *Pelecanus*; but there is no hypapophysis, only a slight median ridge, which also occurs in the fourteenth vertebra. The preaxial surface of centrum does not look so much ventrad; and there is no distinct articular surface at the ventral part of the outer surface of the pleurapophysial lamella. On each side there is a small foramen in the antero-posterior middle of the body, leading into the centrum from just above the ventral margin of the body.

CERVICO-DORSAL VERTEBRÆ.

The SIXTEENTH VERTEBRA has the general character of the corresponding one of *Pelecanus*; but the hypapophysis is still rudimentary. There is no pleurapophysial lamella; but a sharp pointed process projects ventrad from the ventral surface of the distal end of the transverse process, and may be connected with the parapophyses by a minute osseous spiculum forming a rudimentary pleurapophysial lamella, while immediately postaxial to this small ventrally extending process is a subtriangular concave articular surface. The lateral foramen entering the centrum is *very* conspicuous.

The SEVENTEENTH VERTEBRA is generally like that of *Pelecanus*; but the hypapophysis, though a little larger than hitherto, is still very small. The lateral foramen leading into the centrum is smaller than in the sixteenth vertebra, and but very little larger than in the fifteenth.

The EIGHTEENTH VERTEBRA has a long rib ending freely, with an unciform process about as long as the length of that part of the rib which is distal to it.

DORSAL VERTEBRÆ.

The NINETEENTH, TWENTIETH, and TWENTY-FIRST have the general characters of the corresponding ones of *Pelecanus*, except that they are the first three dorsal vertebræ.

The TWENTY-SECOND VERTEBRA is less completely over-shadowed by the pelvis than in *Pelecanus*. It has a rib which is attached very slightly to the parapophysis, against which it abuts by its very slender proximal end. The parapophysis is almost on a level with the root of the diapophysis (Plate LX. fig. 3, XXII).

The TWENTY-THIRD VERTEBRA is similar, and differs from that of *Pelecanus* in that it has a long and slender rib.

It forms part of the ankylosed pelvic mass. The diapophysis and parapophysis are here united into a single "transverse process," and receive the slender proximal end of the fifth thoracic rib.

The TWENTY-FOURTH VERTEBRA is similar, but smaller, more compressed, and with a smaller transverse process.

THE LUMBAR VERTBERÆ.

The TWENTY-FIFTH, TWENTY-SIXTH, and TWENTY-SEVENTH VERTEBRÆ resemble the lumbar vertebræ (the twenty-third, twenty-fourth, twenty-fifth, and twenty-sixth) of *Pelecanus*, except that generally these are only three in number. There are but two presacral foramina on each side, enclosed between their distally expanding parapophyses. Sometimes,

however (as in No. 1186 D in the College of Surgeons' Museum), there are four lumbar vertebræ and three presacral foramina. The more postaxial foramen also is smaller compared with its serial predecessor than is the most postaxial one of *Pelecanus*.

The Lumbo-sacral Vertebræ.

These are generally three in number (normally the TWENTY-EIGHTH, TWENTY-NINTH, and THIRTIETH), and resemble those of *Pelecanus* in most of their characters. Sometimes there are but two such vertebræ.

The Sacral Vertebræ.

These are but one or two[1] in number (from the THIRTIETH, the THIRTY-FIRST and THIRTY-SECOND VERTEBRÆ); and, unlike *Pelecanus*, the parapophysis of the second (when there are two) may be longer and much stronger than that of the first. Their diapophyses arise at a very high (dorsal) level.

The Sacro-Caudal Vertebræ.

They are from four to six in number, including the THIRTY-THIRD, THIRTY-FOURTH, THIRTY-FIFTH, THIRTY-SIXTH, and THIRTY-SEVENTH VERTEBRÆ (Plate LX. fig. 3).

They differ strikingly from those of *Pelecanus* in that they have their parapophyses quite suddenly bent up, so that they are as much differentiated off from the sacral vertebræ as are the lumbo-sacrals in front; and there is consequently a fossa on each side behind the sacral parapophyses. The parapophyses gradually descend postaxially, conjoined with the diapophyses, and being more and more inclined postaxiad.

The last three interparapophysial spaces open widely on the dorsum of the pelvis.

The Caudal Vertebræ.

These are seven[2], apart from the pygostyle, in number. Unlike those of *Pelecanus* they increase in breadth considerably and gradually postaxiad.

A hypapophysis does not appear till the fifth or sixth, and it is longer on the seventh.

The transverse processes are longest in the sixth caudal vertebra. The pygostyle is long, prismatic, with a sharp dorsal ridge; it is ventrally flattened; and its ventral margin is very slightly concave (Plate LIX. fig. 7).

The Pelvis.

This complex structure, including fifteen vertebræ in its extended ankyloses, pretty closely resembles the pelvis of *Pelecanus* (Plate LX. figs. 1–3).

Laterally viewed, however, the opening of the acetabulum is smaller, the sacro-sciatic foramen is longer, the obturator-foramen narrower, and the pubis more postaxially extended (Plate LX. fig. 2).

[1] Very rarely three, as in No. 527 *b* in the British Museum.

[2] There are eight in No. 527 B in the British Museum.

The posterior margin of the ischium looks more dorsad, and develops a much smaller, submedian, truncated or pointed ilio-caudal process[1]. The sacro-iliac ankylosis is relatively as well as absolutely shorter. There is a faint indication of an ilio-pectineal process.

Viewed *dorsally*, the preacetabular iliac surfaces are more concave and very much narrower, so that the sacro-sciatic foramina come plainly into view. The external margin of each ischium is more concave (Plate LX. fig. 1).

The shape of the postaxial margin of the pelvis presents a still deeper excavation, the margins of which (antero-posteriorly considered) are on each side first convex mesiad, and then mesially concave. From the second preaxiad fifth of the convexity (which convexity is formed by the ischium) a process (the ilio-caudal spine) projects mesiad and postaxiad (figs. 1, 2, 3, *lc*).

The transverse diameter between the antitrochanteric processes but little exceeds that of the preaxial part of the ilia, while in *Pelecanus* it is nearly double.

Ventrally examined, the pelvis of *Sula* presents some remarkable differences from that of *Pelecanus*, in spite of the general similarity between the two (Plate LX. fig. 3).

In the first place the ventral surface of the most preaxial part of each ilium extends much more out laterally beyond the ends of the vertebral transverse processes. There are but two presacral foramina on each side[2] (fig. 3, s^1 & s^2).

The renal or lateral acetabular fossæ (f) are relatively, as well as absolutely, smaller. There are but two[3] sacral parapophyses on each side; and behind these there is on each side an elongated fossa produced by the sudden dorsad flexion of the sacro-caudal parapophyses. Did these processes extend out as in *Pelecanus*, they would reach almost, if not quite, to the margin of the ilium. The postacetabular parts of the ilia are so narrow that the sacro-sciatic foramina come plainly into view, there being no wide posterior iliac ventral surface as in *Pelecanus*; also the surface of the sacro-iliac ankylosis is very small.

There is only a very small opening on each side dorsad of the expanded ends of the sacral parapophyses; and this seems only to lead into the substance of the bone; for there is no supraacetabular fossa.

There is an indication of an ilio-pectineal process (*lp*); and the most preaxial part of the obturator-foramen appears from this point of view to be (though it is not) separated off by the here more marked process of the ischium.

[1] This process is very prolonged and pointed in *S. australis* (1186 A), *S. fusca*? (1186 B), and *S. piscator* (1186 C, College of Surgeons); also in a species from Chili (No. 779 A in the British Museum).

[2] As has been said, there may be three.

[3] There may be three or only one, as before stated. Only in *S. capensis* (No. 527 in the British Museum) have I found three such.

The Ilium.

This bone extends over the last and part of the penultimate dorsal vertebræ; and ossification of fascia extends to the preaxial end of the last dorsal vertebra but two, *i. e.* the twenty-second vertebra.

Seen *laterally*, the preacetabular part is less convex dorsally, convex preaxially, and concave postaxially at its ventral margin.

There is a faint indication of an ilio-pectineal process, and a rudimentary posttrochanteric process (figs. 1 & 2, *st*). There are marked antitrochanteric processes (*at*).

The postacetabular part of the ilium has its dorsal margin convex, sloping down ventrad behind the last sacro-caudal, and giving out a short, postaxiad, slightly dorsad process (the ilio-caudal process), which, however, may belong rather to the ischium. This process is greatly extended, and becomes a long pointed process, in some species, as before stated. It is never so wide and massive as in *Pelecanus*. The dorsal margin of the sacro-sciatic foramen is more concave; and the foramen is longer.

The Pubis

is like that of *Pelecanus*, but extends even more postaxiad relatively, and its preaxial part is less bent and convex ventrad. It is somewhat incurved mediad and very much so distally.

The Ischium

has its external smooth antero-posterior groove rather deeper and narrower than in *Pelecanus*, but quite distinct; the process (fig. 2, *ps*) in which its inferior boundary ends preaxially is rather more prominent and distinct. The internal groove is longer, narrower, and in a sigmoid curve (Plate LX. fig. 3, *g*).

The postaxial expanded part of the ischium is smaller; and its postaxial margin slopes more preaxiad and ventrad, and probably develops the ilio-caudal process projecting postaxially at about where it joins the ilium.

The ventral surface of the ilio-ischium postaxiad to the sacro-sciatic foramen (mediad of the ridge bounding the ventral ischiatic antero-posterior groove medianly) is a smooth expanse, as also in *Pelecanus*; but it is here less concave.

The Ribs.

There are seven long vertebral ribs, and six or seven sternal ones.

The Vertebral Ribs.

They increase slightly in length to the fifth or sixth, and expand generally somewhat distally, especially the fourth, fifth, and sixth. The first four[1] have long uncinate processes, which arise more dorsad as we proceed postaxiad. They are a good deal flattened and expanded towards the middle of their superuncinate part.

[1] Five sometimes—*e. g.* in 1186 B, C, and D, College of Surgeons.

The fifth rib has no uncinate process[1]; the flattening and expansion are less and more dorsad; and the tuberculum is reduced to a rudiment.

The sixth and seventh ribs have no unciform process, and no tuberculum whatever. They end proximally in a very slender pointed process, which abuts against the end of the supporting transverse process on the ventral aspect of the ilium.

The Sternal Ribs (Plate LX. fig. 4)

are all long and slender, and differ much in shape from those of *Pelecanus*. They increase in length postaxiad to the fifth and sixth.

The first five expand distally and transversely somewhat, to be implanted in the pleurosteon. The sixth and last is not expanded distally, but presents a small articular facet at its distal end.

The fifth is slightly more than twice the length of the first.

The first and second together about equal the length of the fifth. The last two may be grooved externally.

Sometimes[2] there is a seventh sternal rib, which unites distally with the sixth, and has no ossified vertebral rib to it.

The Sternum (Plate LX. figs. 4 & 5)

is relatively much longer and narrower than in *Pelecanus*. Its keel stretches more preaxiad relatively.

The coracoid grooves (*c*) together form a more acute angle.

The median xiphoid is rounded, or may be slightly emarginate (*mx*). Each lateral xiphoid (*lx*) is somewhat spatulate. The sternum is not generally ankylosed to the clavicles.

The pleurosteon is, again, very much narrower dorso-ventrally than in *Pelecanus*. It presents six articular surfaces (the last very indistinct), separated by five fossæ.

The ventral surface of the sternum is less convex, and its dorsal surface less concave, than in *Pelecanus*, especially in its ventral half.

Its total length is nearly three times its breadth[3], measured transversely at the post axial end of keel.

The coracoid grooves are hardly separated medianly.

The costal angles (*ca*) are less concave on their ventral surface, and are less pointed at their ends.

PHALACROCORAX.

The skeleton of this form is figured, under the title "*Graculus*," by Mr. Eyton in his 'Osteologia Avium,' plate 5 L; and a few words respecting it are to be found at p. 218.

[1] Except as above.

[2] *E. g.* in Nos. 1168, B and C, in the College of Surgeons' Museum.

[3] Not always so much, *e. g.* in 731 A in the British Museum.

A detailed description has been given by Brandt in the 'Mémoires de l'Académie,' before referred to[1], p. 127, with figures of the whole skeleton, the breast-bone, and a back view of the pelvis, in pl. 2.

I have been able to make use of the following skeletons for the purpose of comparison:—A mounted skeleton, No. 1180 (*P. carbo*), and a natural skeleton, No. 1182 *c* (*P. bicristatus*), in the Museum of the Royal College of Surgeons; also a mounted skeleton, a disarticulated natural skeleton, No. 68. 8. 16. 3 (*P. carbo*), a natural skeleton from Chili, No. 76. 9. 26. 16, a disarticulated skeleton, No. 56. 11. 14. 17 (*P. brasiliensis*), and that of a small kind from the Upper Ucayle, No. 16. 3. 28. 17, all in the British Museum.

I am also indebted to Professor Garrod for the loan of a specimen.

The total number of vertebræ, without counting the pygostyle, seems to be from forty-six to forty-nine.

These vertebræ are subdivisible as follows—eighteen cervical, two cervico-dorsal, five dorsal, five lumbar, two lumbo-sacral, two sacral, seven or eight sacro-caudal, and five to eight caudal, besides the pygostyle.

There are constantly five dorsal vertebræ, and twenty cervical and cervico-dorsal vertebræ taken together; but there may be eighteen cervical and two cervico-dorsal vertebræ, or seventeen cervical with three cervico-dorsals. The lumbar vertebræ are generally five in number, but may be only four. The lumbo-sacrals may, by rare exception, be reduced to one, or augmented to three. There may be but one vertebra apparently distinguished as a sacral vertebra. The sacro-caudals and caudal vertebræ taken together are generally as many as fourteen; but they may be only thirteen, or as many as sixteen; and always either seven or eight of these ankylose with the pelvis, and so come to be reckoned as sacro-caudal vertebræ.

The whole axial skeleton, when compared with that of *Sula*, is a somewhat yet denser structure; and the various ridges and processes are sharper and relatively more developed. Median hypapophyses are not only much more developed than in *Sula*, but even than in *Pelecanus*, especially in the anterior sacral region. Hyperapophyses are also relatively larger than in either of the former genera. The styloid rib-like processes are free, as in *Sula*, and even somewhat longer relatively, being decidedly more slender.

The Cervical Vertebræ.

These vertebræ, when compared with those of *Sula*, present a very close resemblance, but are longer relatively and more hypapophysial, with a more slender and prolonged styloid rib (p. 35). They are more numerous than in *Sula* or *Pelecanus*; and thus the sudden change of form takes place over vertebræ more postaxiad than in those genera.

The atlas has its preaxial articular surface rather less circular, broader relatively dorsally, and narrower ventrally. There is an odontoid foramen; but it is less decidedly

[1] See above, p. 315.

enclosed dorsally. The hyperapophyses are still longer and more diverging, and consequently the postaxial margin of the neural arch more concave (Plate LVII. figs. 1–3).

There are three hypapophysial processes:—one long median, laterally compressed; and two small pointed lateral ones, which are really rudimentary styloid ribs.

The AXIS (Plate LVII. figs. 4 & 5) has its hyperapophyses somewhat less developed than in *Sula*; its hypapophysis more convex preaxially, curved so that its tip is almost dorsad; and instead of the two minute pointed lateral processes in front of the hypapophysis there are two longer processes connected medianly with the hypapophysis—in fact, two small, but distinct, rib-like styloid processes (*ps*) which, considered by themselves, might be either catapophysial or parapophysial, but which should rather be considered parapophysial, as they are evidently in series with the parapophysial processes which succeed them postaxially. There is no lateral foramen leading into the centrum.

The THIRD VERTEBRA (Plate LVII. figs. 6 & 7) is longer in proportion to its breadth than in *Sula*. The præzygapophyses look somewhat less directly dorsad. The spine and hyperapophyses are sharper and more developed. The postzygapophyses are more concave and directed more postaxiad. The styloid rib-like processes are smaller relatively, as well as absolutely, than in *Sula*, though they have greatly increased compared with those of the axis.

The FOURTH VERTEBRA differs much as does the third, except that the hypapophysis is less (is much less) dorso-ventrally developed, though more equally so for a greater part of its length antero-posteriorly.

The FIFTH VERTEBRA is not grooved beneath, but has an antero-posteriorly elongated hypapophysial ridge but little prominent.

The SIXTH VERTEBRA is also ridged beneath instead of grooved; and the neural spine and especially the hyperapophyses and metapophyses are generally more sharply prominent; but the styloid rib-like processes are hardly less developed relatively.

The SEVENTH VERTEBRA (Plate LVII. figs. 8–11) is grooved beneath, for the first time (as is the fifth of *Sula*), and (as also that fifth) rudimentary; catapophyses begin to appear at the preaxial part of the groove. It differs from the seventh vertebra of *Sula* in that it is grooved beneath narrowly instead of broadly; otherwise it differs from the vertebra of the same number in *Sula* as does the sixth; but the fossa at the preaxial part of its ventral surface is deeper. The styloid rib starts postaxiad from the outer side of the antero-posteriorly grooved lamella of bone which exists on each side of the preaxial end of the median subcentral groove, and is plainly parapophysial, as it is in *Sula*.

The EIGHTH VERTEBRA (Plate LVII. figs. 12–16) differs from the eighth of *Sula* in not being pressed back preaxially, and in not diverging widely postaxially; and the metapophyses are not here suddenly increased. The præzygapophyses still project decidedly preaxiad of the centrum; and the postzygapophyses[1] diverge but little more than in the

[1] These have here their articular surface more elongated and quite extending to the postaxial ends of the processes, which they do not in the seventh vertebra, and hardly in the seventh of *Sula*. In *Pelecanus* they

seventh vertebra, though the hyperapophyses have come to join and diverge from the neural spines. Thus this vertebra is like the seventh of *Pelecanus*. *Sula* is intermediate, since in it the seventh vertebra does not bifurcate postaxially, as in *Pelecanus*, yet the preaxial part of the eighth is more pressed back than that of the seventh of *Pelecanus*, and less so than that of its eighth vertebra.

The postzygapophyses look more externad than either in *Pelecanus* or *Sula*.

The styloid processes are much larger than in the seventh vertebra.

In the eighth vertebra the styloid process has come to start rather from the middle than from the external border of the groove on each side of the preaxial part of the median subcentral groove. It has thus become rather catapophysial than parapophysial, and the same change has taken place here as has been described as occurring in the corresponding vertebra of *Sula*.

The NINTH VERTEBRA (Plate LVII. figs. 17–20) is, like the ninth of *Sula*, elongated; but the neural spine is smaller, and the præzygapophyses look more mesiad. It evidently corresponds with the eighth of *Pelecanus*, though there is no hæmal arch, it being the first one in which the preaxial part of the vertebra is pressed in postaxiad, with a transverse constriction behind the præzygapophyses. The three tubercles outside the pleurapophysial lamella are distinctly developed, with the parapophysial projection below them, as in *Sula*. The rib-like styloid processes are larger and more slender than in the eighth vertebra, and much more so than in the ninth vertebra of *Sula*.

The TENTH VERTEBRA (Plate LVII. figs. 21–23) is, like the tenth of *Sula*, somewhat drawn out; but there is no hæmal arch[1]. In this and the preceding vertebra in *Sula* the rib-like styloid process is antero-posteriorly grooved on its ventral surface—not so in *Phalacrocorax*.

The ELEVENTH, TWELFTH (Plate LVII. fig. 24), and THIRTEENTH VERTEBRÆ are, like those of *Sula*, somewhat lengthened; but in none is the hæmal arch completely closed ventrally. In the eleventh vertebra the postzygapophyses fail, for the first time, to attain the postaxial limit of the centrum. In the last of these vertebræ the styloid rib-like process reverts to its condition in the seventh vertebra, inasmuch as it here again extends from the *external margin* of the lateral antero-posterior subcentral groove; *i. e.* it is again rather parapophysial; and the parapophysial projection, distinct in the ninth, tenth, and eleventh vertebræ, has here coalesced with the root of the rib-like process.

The FOURTEENTH VERTEBRA is substantially like that of *Sula's* fourteenth vertebra; but when viewed dorsally it is more constricted laterally, the præzygapophyses look more directly mediad; the neural spine is more developed, ending in a sharp dorsad and postaxiad process at its postaxial end. Viewed laterally, a large, median, laterally compressed hypapophysis here appears suddenly for the first time, largely perforated

do so already in the sixth vertebra. In all three genera the processes begin again to project postaxiad of the articular surface in the fifteenth or sixteenth vertebra.

[1] The styloid ribs are excessively long in this and adjacent vertebræ of 1182 c in the College of Surgeons.

towards its postaxial margin. The metapophysial ridge is more developed; and beneath it are two very strong antero-posterior ridges (separated by a marked concavity), outside the pleurapophysial lamella, from the ventral postaxial angle of which a rib-like styloid process extends postaxiad.

At the preaxial end of the ventral surface of the centrum there is a sharply limited fossa just preaxial to the hypapophysis[1].

In the next vertebra the postzygapophysial process again begins to extend postaxiad beyond the articular surface—as also in *Sula* and *Pelecanus*.

The FIFTEENTH VERTEBRA (Plate LVII. figs. 25–29) is like the fourteenth, and the fourteenth of *Sula*, except that the neural spine is a little more developed; the styloid processes are rudimentary. It differs from the fifteenth of *Sula* in that the neural spine is so much less developed. The pleurapophysial lamella is wide, as in the fourteenth vertebra of *Sula*. A lateral foramen sometimes leads into the substance of the bone; only, instead of being situated close to the ventral surface, it is just below the interzygapophysial ridge. The hypapophysis is largely developed.

The SIXTEENTH VRETEBRA closely resembles the fifteenth of *Sula*, only that there is a large, long hypapophysis, instead of a slight median ridge. There is a lateral foramen, as in the fifteenth vertebra.

The SEVENTEENTH VERTEBRA is very like the sixteenth of *Sula*, only that there is a large hypapophysial process, that the lateral canal is still completed below by an osseous bridge, that the hyperapophyses are more developed, and the postaxial articular surface of the centrum more developed transversely.

The EIGHTEENTH VERTEBRA (Plate LVII. fig. 30) is like the seventeenth of *Sula*, but that there is a larger hypapophysial process, that the lateral canal is still completed below by a delicate osseous bridge, that the hyperapophyses are more developed, that the postaxial articular surface of the centrum is more extended transversely in proportion to its dorso-ventral development, and that the postero-external angle of the centrum, in its ventral aspect, is drawn out into a triangular process of bone, which extends slightly ventrad. From the outer end of the ventral surface of the transverse process a pointed process, more or less developed, extends externad and ventrad; and sometimes[2] there may be, instead of a ventral bony bridge, a long, delicate, movable rib, with both capitulum and tuberculum.

CERVICO-DORSAL VERTEBRÆ.

There are generally but two of these (Plate LVII. figs. 31–36).

The NINETEENTH VERTEBRA is like the eighteenth of *Sula*, except that there is a long and narrow hypapophysis, that the præzygapophyses are smaller and produced relatively more dorsad, and that the hyperapophyses are drawn out into long, bony, very slender

[1] This does not occur till the fifteenth vertebra in 1182 c.

[2] As in No. 76. 9. 26. 16 of British Museum.

processes. The centrum is more laterally compressed than in *Sula*; and there is a ridge running antero-posteriorly on each side of the origin of the hypapophysis.

The TWENTIETH VERTEBRA is like the nineteenth of *Sula*, except that it has become distinctly opisthocœlous (fig. 36), and that there is a long hypapophysis, that it is still more compressed laterally, and has no marked antero-posterior ridge on each side of it.

The Dorsal Vertebræ.

These are much more compressed laterally than in *Sula* or *Pelecanus*.

The TWENTY-FIRST VERTEBRA (Plate LVII. figs. 37–39) has on its preaxial articular surface a median tract (of about one third of its total width) convex in both directions, and external to this, on each side, a tract which is concave from within outwards. Its postaxial articular surface is more simply and entirely concave than is that of the twentieth vertebra. There is a long hypapophysis, a little antero-posteriorly expanded at its distal end. This and the succeeding dorsal vertebræ have styliform ossifications of tendon attached to the dorsum of the distal part of their transverse processes; and the neural spines are, to a less extent, similarly affected.

The TWENTY-SECOND and TWENTY-THIRD VERTEBRÆ (Plate LVII. figs. 40–45) are simply convex in front, centrally, and concave behind, each surface being much more dorso-ventrally than transversely extended. The hypapophyses are nearly as in the twenty-first vertebra.

The TWENTY-FOURTH VERTEBRA is the first to form part of the ankylosed pelvic mass; its preaxial surface is like that of its serial predecessor, except that it is somewhat broader. The hypapophysis is slightly smaller (Plate LX. fig. 6, XXIV).

The TWENTY-FIFTH VERTEBRA is like its predecessor, but is smaller, more compressed, and with a smaller hypapophysis. Generally the hypapophysis of this vertebra is (like its three serial predecessors) distinctly flattened ventrally; but it may not be so, and may be quite rudimentary, as in the smaller skeletons in the British Museum, 68. 8. 16. 3. 56. 11. 14. 17 and 66. 3. 28. 17.

The Lumbar Vertebræ.

The TWENTY-SIXTH, TWENTY-SEVENTH, TWENTY-EIGHTH, TWENTY-NINTH, and THIRTIETH VERTEBRÆ resemble the lumbar vertebræ of *Sula*, save in their greater number, the presence of distinct hypapophyses to the first two, and the presence, generally, of three presacral foramina on each side, produced by the distal junction of the parapophyses of the four most postaxial lumbar vertebræ; there may, however, be as many as four presacral foramina.

The Lumbo-sacral Vertebræ.

From the intervertebral foramina there appear generally to be two lumbo-sacral

vertebræ—the THIRTY-FIRST and the THIRTY-SECOND,—although there may be as many as three, or sometimes, apparently, but one.

The Sacral Vertebræ.

Of these there are at most but two, the THIRTY-THIRD and the THIRTY-FOURTH.

They differ from those of *Sula* in that, though the first has, like that of *Sula*, its parapophysis detached from more dorsal ossification, that of the second (thirty-fourth vertebra) often, if not generally, has its parapophysis continuously ossified with what is dorsal to it, so as to constitute a little subvertical sheet of bone formed of parapophysis and diapophysis conjoined (Plate LXI. fig. 1).

The Sacro-caudal Vertebræ.

These are seven or eight in number, from the THIRTY-FIFTH to the FORTY-SECOND inclusive (Plate LXI. fig. 1). The condition of their parapophyses is generally intermediate between *Pelecanus* and *Sula*, not even arising so ventrally as in the former and not generally bent up dorsad so suddenly as in the latter, except in the thirty-fifth vertebra, where they are quite so. Their general appearance, however, is more like that presented by *Sula* than by *Pelecanus*. They are subequally developed as to the transverse extent of their parapophyses; and the last two considerably increase in antero-posterior extent.

The Caudal Vertebræ.

These vertebræ, from five to eight in number, rapidly increase in transverse diameter; and the second may have a hypapophysis, while the third has generally a distinctly bifurcating hypapophysis, which becomes much larger in the succeeding two vertebræ. Each vertebra has a pair of small zygapophyses (Plate LXI. fig. 5).

The PYGOSTYLE is very different in shape from that of either *Pelecanus* or *Sula*. It is much shorter and sharply bent up dorsad upon the free caudals; its ventro-postaxial margin is gently concave, and its dorso-preaxial one gently convexo-concave postaxiad—both as in *Sula*; but it is a very much shorter bone, and may even approximate in outline to an equilateral triangle, though it may be a triangle of which the breadth is but half the length.

The Pelvis.

This includes as many as from fifteen to seventeen vertebræ. It more nearly resembles that of *Sula* than that of *Pelecanus*, but is more elongated antero-posteriorly.

Viewed *laterally* it agrees with *Sula*, and differs from *Pelecanus* in the points mentioned in describing *Sula*, except that the sacro-iliac ankylosis is longer, and the ilio-caudal spine is a very long pointed process (Plate LX. fig. 6).

Compared with *Sula*, the sciatic foramen is more pointed postaxially, and, as in

Pelecanus, narrower (dorso-ventrally) behind than in front, instead of the reverse, as generally in *Sula*.

The pubis is shorter and curved more sharply ventrad at its postaxial end.

Viewed *dorsally*, the antero-posterior excess in length of the postacetabular part is greater; and the ilia expand at their preaxial ends in a wing-like manner, the external margin of the ilium behind the expansion being much more concave, while a strong but narrow ridge divides the two iliac fossæ. The sacro-sciatic foramina are about as visible as in *Sula*; but the postaxial margin of the pelvis is very different, the ilio-caudal spines (*lc*) projecting postaxiad generally more, often considerably more, than the ischium, and nearly as much as the pubis. The angle formed by this spine with the adjacent margin of the ischium is acute. The transverse diameter of the pelvis at the antitrochanteric processes is even exceeded by that of the preaxial ends of the ilia. The postaxial half of the external margin of the ischium is convex instead of being concave as it is in *Sula*. The defects of pelvic ossification generally extend preaxiad to quite between the acetabula (Plate LXI. fig. 2).

Ventrally examined (Plate LXI. fig. 1), the pelvis of course repeats the characters which can be seen thus as well as by the dorsal view; and, in addition, the ventral surface of the most preaxial part of each ilium extends more out laterally beyond the ends of the transverse processes than even in *Sula*. There are generally three small presacral foramina on each side—the first the largest, the second the longest, the third the smallest and round.

The lateral acetabular fossæ (*f*) are smaller than even in *Sula*, and rhomboidal in outline. The parapophysis of the second sacral vertebra, ankylosing, as it often if not generally does, with the ilium above, forms a complete postaxial boundary to the lateral fossa in front of it—that fossa extending above (dorsal to) the parapophysis of the first sacral vertebra—and at the same time to the posterior iliac fossa behind it. Thus there is no trace whatever of the large opening which extends in *Pelecanus* above the expanded ends of the sacral parapophyses. There is no supraacetabular fossa.

The parapophyses of the last lumbar vertebra abut directly against the preaxial margin of the acetabulum, instead of some distance preaxial to it as in *Sula* and *Pelecanus*. The antero-posterior ridge inside the ischium, bounding its groove (*g*) mesially, is more sharply marked than in *Sula* or *Pelecanus*; and the extent of ischium ventrad of the more postaxial part of that ridge is very much greater.

The Ilium.

This bone extends over the twenty-fifth (or last dorsal) vertebra and part of the one preceding.

Seen laterally, the dorsal margin of the preacetabular part is slightly more convex, and its ventral margin is more convex preaxially and concave postaxially; there is a slight indication of an ilio-pectineal process (*lp*).

The ilio-caudal process (*lc*) is pointed and very long, extending directly postaxiad and beyond the postaxial end of the ischium. The sacro-sciatic foramen is longer and more pointed postaxially; at the anterior part of its dorsal margin a very distinct post-trochanteric process (*st*) is developed postaxial to the antitrochanteric process, removed from it by a distance rather less than the diameter of the acetabulum[1].

The Pubis

is more sharply bent down ventrad towards its distal end.

The Ischium

has its external smooth antero-posterior groove hardly, if at all, deeper than in *Pelecanus*. The process (*ps*) in which it ends preaxially, is rather more marked than in *Sula*.

The internal (ventral) groove (*g*) is much as in *Pelecanus*, but more expanded towards its postaxial end. The part postaxial to the sciatic foramen is more expanded than in *Sula*, and is more as in *Pelecanus*.

The ventral surface of the ischium behind the sciatic foramen (and mediad of the very strong ridge bounding medianly the antero-posterior ventral groove) is smooth; it is less concave than in *Pelecanus*, but more extensive than in *Sula*.

The Ribs.

There are seven vertebral and five sternal. There may be eight vertebral ribs when the eighteenth cervical vertebra bears one.

The Vertebral Ribs.

The first two have no sternal ribs; all, or all but the last, have uncinate processes; these processes are more developed than in *Sula*.

The last ends proximally in a filamentary process, and then ankyloses with the pelvis.

The first rib joining the sternum is the broadest.

None are much expanded distally.

The Sternal Ribs.

These increase in size postaxiad (Plate LXI. fig. 3).

The last is not double generally, but may be so.

The fourth is twice as long as the first; the fifth is longer.

None are very much expanded distally.

The fourth and fifth may unite before joining the sternum.

[1] In 1182 c this process becomes an antero-posteriorly extended ridge.

The Sternum.

The sternum (Plate LXI. figs. 3 & 4) is shorter and broader than in *Sula*, with the proportions of *Pelecanus*, but less contracting, laterally, postaxiad. The clavicles are not ankylosed to it.

The keel extends much relatively as in *Pelecanus*; and the coracoid grooves form an angle much as in that genus, and therefore a less acute one than in *Sula*. The median xiphoid (*mx*) agrees with that of *Sula* in not extending postaxiad as much as the lateral xiphoids do, thus differing from *Pelecanus*. These lateral xiphoids are obtusely pointed, not spatulate (*lx*).

The pleurosteon may have only four elongated articular processes in *Ph. carbo*, but generally has five such in other species.

The concavity and convexity of the sternal osseous sheet is much as in *Pelecanus*, and not flattened as in *Sula*, though the middle part of the postaxial portion of its ventral surface is not so convex transversely as in *Pelecanus*.

The articular surface behind the coracoid groove is not so broad relatively as either in *Sula* or *Pelecanus*.

A process may spring preaxiad from dorsal end of concave dorso-preaxial margin of keel.

PLOTUS.

The anatomy of *Plotus* has been recently described by Professor Garrod, in a very interesting and instructive memoir in the 'Proceedings' of the Zoological Society for 1876, p. 335, pls. 26 to 28. Its skeleton was noticed by Mr. Eyton in his 'Osteologia Avium,' p. 218; and by W. Donitz (as concerns the cervical vertebræ) in the 'Archiv für Anatomie und Physiologie,' 1873, p. 357, plate ix. A.

It has been described with much detail by Brandt, who has given figures of the entire skeleton, the pelvis, and sternum, in the 'Mémoires de l'Académie des Sciences de St.-Pétersbourg,' 6^{me} serie, Sciences Mathématiques, Physiques et Naturelles, tome v. seconde partie, Sciences Naturelles, tome iii. 1840, p. 132, pl. 4.

I have myself examined a skeleton of *Plotus anhinga* in my own collection, and also another and a skeleton of *P. novæ-hollandiæ*, both in the Museum of the Royal College of Surgeons.

The total number of vertebræ seems to be 45 or 46, without counting the pygostyle.

These vertebræ are subdivisible as follows—18 cervical vertebræ (in the specimen of *P. novæ-hollandiæ* there are only 17; but this is probably owing to one vertebra, the 15th, having been lost), 2 cervico-dorsal, 5 or 6 dorsal (in one specimen of *P. anhinga* there are but 5), 4 lumbar, 2 or 3 lumbo-sacral, 2 sacral, 4 sacro-caudal, and 7 or 8 caudal vertebræ.

The whole axial skeleton, when compared with those of the genera previously described, presents a remarkable contrast in the great prolongation of its more preaxial part, while its pelvic part is somewhat shortened, notably as compared with the same part in *Phalacrocorax*, with which genus, nevertheless, the axial skeleton of *Plotus*, on the whole, most agrees. Thus it agrees with *Phalacrocorax* in the strongly opisthocœlous condition of the trunk-vertebræ, and in their median, subcentral, laterally compressed prominences, though (as we shall see) they have not the same nature as the analogous parts in *Phalacrocorax*.

In the elongation of the anterior cervical vertebræ *Plotus* is more nearly approached by *Pelecanus*; but these bones are not nearly so long and slender relatively in the last-named genus, nor are they so smooth dorsally and with such rudimentary neural spines as in *Plotus*.

The Cervical Vertebræ.

These vertebræ, from their length and the little relative prominence of their processes, resemble (as has just been said) the cervical vertebræ of *Pelecanus*; but in number and essential details of structure they rather resemble those of *Phalacrocorax*, presenting at the same time a number of special peculiarities.

As has been pointed out by Professor Garrod[1] the vertebræ are mostly long to the eighth, which is extraordinarily elongated (as also the third, fourth, and fifth), and forms an angle open ventrad with its predecessor, and an angle open dorsad with its successor.

The styloid rib-like processes are little developed in the first seven vertebræ, but in the eighth and succeeding ones much so, above all in the eighth, where their length is such as to extend peculiarly ventrad, and postaxiad of the preaxial end of the hæmal arch of the vertebra next behind, *i. e.* the ninth.

The atlas is much like that of *Phalacrocorax*; but there are no lateral hypapophysial processes, and the hyperapophyses project less postaxiad, scarcely more so than in *Pelecanus*. The odontoid foramen is smaller, relatively as well as absolutely, than in any of the three preceding genera (Plate LVIII. figs. 1 & 2).

The axis differs remarkably from that of all the three preceding genera in its great relative antero-posterior length and little dorso-ventral extent, due principally to the small development of the hypapophysial element; it is also relatively less broad transversely (Plate LVIII. figs. 3 & 4).

The odontoid process is very small. There is a distinct, elongated, though low, neural spine. The articular surfaces of the postzygapophyses project as much postaxiad as do the zygapophyses themselves. There is an interzygapophysial ridge. The postaxial articular surface of centrum looks dorsad as well as postaxiad; and its ventral margin is strongly concave. The ventral surface of the centrum presents three antero-posterior

[1] Proc. Zool. Soc. 1876, p. 336-7.

ridges:—one median, hypapophysial ridge, extending to about the postaxial end of the preaxial two thirds of that surface; and two lateral, parapophysial ridges (fig. 4, *hy'*), extending and diverging postaxiad till each ends in a process on the ventral side of the external ventral angle of the postaxial articular surface of the centrum. There thus comes to be a small fossa beneath the postaxial third of the centrum. The postzygapophyses project postaxiad much beyond the postaxial end of the centrum.

In *Plotus novæ-hollandiæ* the hypapophysial ridge is more developed, and extends almost to the postaxial end of the centrum, while the lateral ridges are like delicate rib-like styloid processes, there being a defect of ossification in each.

The THIRD VERTEBRA (Plate LVIII. figs. 5 & 6) is almost half as long again as is the second. It is, like the third of *Pelecanus*, greatly drawn out, and with the neural spine and hypapophysis all but entirely suppressed. There is no interzygapophysial ridge. The postaxial half of the median hypapophysial ridge is replaced by a narrow, shallow groove, the margins of which must be reckoned as catapophysial, while a parapophysial ridge runs along each side of the ventral surface of the centrum, and ends postaxially in a rib-like styloid process, which begins to project freely ventrad as well as postaxiad at about the preaxial end of the postaxial fourth of the centrum, almost extending postaxiad as far as the preaxial end of the postaxial articular surface of the centrum. A small tubercle (which may be either the representative of a tubercular process or a metapophysis) projects just behind the præzygapophysis and above the tubercle at the preaxial end of the parapophysial ridge. From the former tubercle a slight ridge descends obliquely to join the parapophysial ridge at about its middle.

The FOURTH VERTEBRA (Plate LVIII. figs. 7 & 8) is about equal in length to the third, and is quite like it, except that the median subcentral groove is a little deeper and extends along the whole length of the centrum. At the postaxial end of the preaxial third of each lateral margin of the subcentral groove a small catapophysial process projects downwards, while between such lateral margin and the more externally situated preaxial part of the parapophysial ridge (*p'*) is an antero-posterior groove (fig. 8, *g*) which corresponds with the similarly situated groove beneath the fifth and sixth vertebræ of *Pelecanus*. The styloid process begins to start out at a point slightly more preaxial.

The FIFTH VERTEBRA (Plate LVIII. figs. 9–11) is like the fourth, except that it is very slightly shorter, and that the styloid processes are again a little more preaxial, and the postzygapophyses extend postaxiad a little beyond their articular surfaces.

The SIXTH VERTEBRA (Plate LVIII. figs. 12–14) is decidedly shorter, not greatly exceeding the axis in length; and here, while the catapophysial margins of the subcentral groove are more raised, the styloid processes are shorter and more preaxial, a wide, subequal, antero-posterior groove extending between the catapophysial and parapophysial ridges. Here a neural spine begins to reappear[1], the postzygapophyses are

[1] In *Plotus novæ-hollandiæ* it begins in the fifth vertebra.

rather more distinct, though still small, and the hyperapophyses are decidedly more marked than in the fifth vertebra.

The SEVENTH VERTEBRA (Plate LVIII. figs. 15–17) is, again, a trifle shorter, but little exceeding the axis in length. Compared with the last vertebra, the styloid processes are yet shorter, and (as in that vertebra) project but very little from the side of the centrum, and are separated from the adjacent catapophysial ridges by a wider, though somewhat shorter, antero-posterior groove. The neural spine is higher; the hyperapophyses and the metapophyses are stronger; and the postzygapophyses almost look a little preaxiad as well as ventrad, and a little externad. As in the sixth vertebra, so here the plane of the styloid processes was more dorsad than that of the hinder part of the centrum's ventral surface. The centrum being a little bent on itself from before backwards, its ventral margin (when viewed laterally) is a little concave ventrad.

A narrow fissure runs preaxiad from the middle of the postaxial margin of the neural arch; and on each side of this, between it and the adjacent hyperapophysis, is an antero-posteriorly directed groove.

The EIGHTH VERTEBRA (Plate LVIII. figs. 18–22) agrees with that of *Phalacrocorax*, and differs from that of *Sula* and *Pelecanus*, in that it articulates with its predecessor at an angle open ventrad, as in the more anterior vertebra, while with its successor it articulates at an angle open distad; but it presents characters altogether peculiar. As in the seventh of *Pelecanus* and the eighth of *Phalacrocorax*, the neural spine is more preaxially situated than in its serial predecessor (projecting from about the antero-posterior middle of the neural arch); and, as in the seventh of *Sula* and eighth of *Phalacrocorax*, the styloid processes diverge ventrad from the centrum as they proceed postaxiad. Unlike, however, all the three before-described genera, these styloid processes are enormously long, extending more postaxiad than any other part of the vertebra, and reposing upon the sides of the hæmal arch of the ninth vertebra. The postzygapophyses also do not project postaxiad as much as does the centrum; and their articular surfaces (which are elongated) look more directly externad than even in *Phalacrocorax*—though, as in that genus, they differ from those of the sixth vertebra by quite extending to the postaxial ends of those processes. The preaxial part of the neural arch is not pressed back postaxiad; but the postaxial part of that arch rises dorsad—instead of being curved over ventrad very markedly, as it is in the seventh vertebra; also the postaxial margin of the neural arch, seen dorsally, is more concave than in the preceding vertebra, and without any narrow median cleft. The præzygapophyses still extend decidedly preaxiad of the centrum. The long styloid processes cannot well be determined as more catapophysial or parapophysial; for they arise from the same part as the parapophysis arises from in the seventh vertebra, while they are continuous dorsally with the preaxial part of the marked catapophysial ridges, which bound laterally the median subcentral groove; these latter ridges are externally concave dorso-ventrally, this concavity being

bounded above by an antero-posterior ridge. This lateral groove ends preaxially in a small, but deep, fossa enclosed externally by the external root of the styloid process.

The NINTH VERTEBRA (Plate LVIII. figs. 23–27) is very much shorter than the eighth, being scarcely, if at all, longer than the axis. It agrees with the ninth vertebra of *Phalacrocorax* in being the one to present the marked contrast, to be the first pressed back postaxiad at its preaxial part, and to be articulated with its two adjacent vertebræ at angles both open dorsad. It thus agrees with the eighth vertebra of *Pelecanus* and of *Sula*.

Here in *Plotus* is a hæmal arch for the first time developed, and developed suddenly, and at once in its completeness. It extends much preaxiad of the centrum, while neither pair of zygapophyses may extend quite as far, pre- and postaxially respectively, as does the centrum; the præzygapophyses never do so.

The neural arch is much cut away preaxially; and the preaxial articular surface of the centrum looks mainly dorsad. The præzygapophysial surfaces look mediad and very slightly postaxiad. These processes are produced dorsad and postaxiad like those of the tenth vertebra of *Phalacrocorax* and the ninth of *Pelecanus*.

The neural spine is very small, and close to the concave postaxial margin of the neural arch. Hyperapophyses are more developed, and have retreated preaxiad from the ends of the postzygapophyses. In *Plotus anhinga*, immediately in front of each hyperapophysis is another small process (fig. 24, *hp'*), of smaller size; to this one end of a strong tendinous arch is attached, the other end of which is implanted in the dorso-postaxial angle of the præzygapophysis of the same side. In *P. novæ-hollandiæ* this tendon is ossified, forming a bony arch. These bony arches arise from a point on the dorsum of the neural arch which seems to represent spine and hyperapophysis; and no neural spine is developed. Preaxially each arch goes to the metapophysial prominence outside the præzygapophysis. We here find, for the first time in the series, a conspicuous lateral canal, which is short, and opens preaxially dorsally to the centrum. Oblique metapophysial ridges project from the outer surface of the præzygapophyses. The hæmal arch is notched medianly preaxially, with a small, ventrad, median prominence behind it. The styloid processes reach almost to the postaxial end of the centrum. It is hard to say whether they are catapophysial or parapophysial in nature; but marked catapophysial ridges bound on each side the median, subcentral canal.

The TENTH VERTEBRA (Plate LVIII. figs. 28–30) is slightly longer than the ninth, and is like it except that the postaxial margin of the neural arch is a little more concave, that there is no neural spine, that the hyperapophyses are larger, the styloid processes are shorter, the outside of the præzygapophysis is more rugged, and the postzygapophyses begin always to project again a little postaxiad of the postaxial end of the centrum. The hæmal arch has a strong median ridge running antero-posteriorly on its ventral surface; and the catapophysial ridges (bounding laterally the median, subcentral groove) are, as usual in *Plotus*, strongly marked.

The ELEVENTH VERTEBRA (Plate LVIII. figs. 31 & 32) is of about the same length as

the tenth, and is like it except that the præzygapophyses again extend a little less dorsad (as they have begun to do in the tenth vertebra), while from behind the summit of each a sharp, pointed, metapophysial process extends dorsad, postaxiad, and externad. The hyperapophyses are more developed (especially elongated); and there is no longer any trace of a neural spine.

The median ventral ridge of the hæmal arch has here become a very sharp, plate-like, prominent process.

The TWELFTH VERTEBRA (Plate LVIII. fig. 33) is of about the same length as the eleventh, and is like it except that the hind ventral process of the hæmal arch is more prominent, the hyperapophyses are larger, and the postzygapophyses here again begin to fail to extend postaxiad so far as does the centrum.

The THIRTEENTH VERTEBRA is slightly shorter than the twelfth, and repeats its characters a little more strongly marked, except that the hæmal arch projects preaxially to the centrum in a somewhat less degree. The hyperapophyses project sharply and strongly dorsad and preaxiad.

The FOURTEENTH VERTEBRA is again a little shorter. The postzygapophyses begin to project postaxiad slightly beyond their articular surfaces. It has no longer the pointed process just postaxial to the præzygapophysis, or only a rudiment of such. Long catapophysial ridges limit laterally the subcentral groove, though they altogether disappear in the next vertebra.

The FIFTEENTH VERTEBRA (Plate LVIII. figs. 34–36) is of about the same length as the fourteenth. It is like it; but the rib-like styloid processes are stouter, more externally placed, and are more decidedly parapophysial. The hæmal canal has ceased to exist; and in its place is a long plate-like hypapophysis, which may be perforated.

The hyperapophyses converge preaxiad, and may meet to indicate a rudiment of a neural spine[1]. The postzygapophyses begin again to project postaxiad a little beyond the centrum.

The SIXTEENTH VERTEBRA is of about the same size as its serial predecessor, but differs from it markedly in the sudden development of a long neural spine, curved postaxiad at its tip. There is also a still larger plate-like hypapophysis, projecting postaxiad of the centrum, and considerably larger than in the corresponding vertebra of *Phala crocorax*. The præzygapophyses begin again to extend preaxiad as much as does the centrum. The rib-like styloid processes are shorter and stouter, and notched preaxially, while the lamella, enclosing dorsally the lateral vertebral canal, extends more postaxiad, and is therefore longer antero-posteriorly than in the fifteenth vertebra.

The SEVENTEENTH VERTEBRA is of about the same size as the sixteenth; but its neural

[1] This vertebra, in the specimen of *P. novæ-hollandiæ* in the Royal College of Surgeons' Museum, has a neural spine more developed than has even the sixteenth vertebra of *P. anhinga* (in either specimen), while its fourteenth vertebra is quite like the fourteenth vertebra of *P. anhinga*. This, coupled with the defective number of cervical vertebræ, makes it probable that the fifteenth is lost in this specimen.

spine is much more extended antero-posteriorly, while its hypapophysis is much reduced (not being larger than in *Phalacrocorax*), but still extending postaxiad of the centrum. The rib-like styloid process is still shorter and more notched preaxially; while the lamella of bone enclosing dorsally the lateral vertebral canal is still more antero-posteriorly extended, and also more outwardly. The ventral surface of the centrum is flattened and much broader than in the sixteenth vertebra, while its external margins are developed with lateral catapophysial ridges.

The EIGHTEENTH VERTEBRA (Plate LVIII. figs. 37 & 38) is like the seventeenth, except that the neural spine is still more elongated antero-posteriorly, and dorsally flattened, and the hypapophysis still more diminished, the centrum still more flattened beneath, and its lateral ridges more developed. While the lamella enclosing the lateral canal dorsally is as large, there is ventrally but a slender osseous bridge, the point of junction between which and the dorsal plate is the last rudiment of the styloid process.

THE CERVICO-DORSAL VERTEBRÆ.

In the NINETEENTH VERTEBRA, compared with the eighteenth, the transverse processes extend less outwards and are inclined more postaxiad, and the lateral hypapophysial ridges are more developed, while the root of the median hypapophysis extends further preaxiad (Plate LVIII. figs. 39 & 40).

Compared with the nineteenth vertebra of *Phalacrocorax*, the transverse processes extend much less outwards, the hypapophysis is much more postaxially situated, and more inclined postaxiad distally. The centrum is very much less laterally compressed, and very much more flattened ventrally, with lateral hypapophysial ridges much more laterally extended; these ridges cannot be parapophysial, because the heads of the ribs articulate dorsally to them. The postaxial articular surface of the centrum is much more extended transversely; and the præzygapophyses are relatively as well as absolutely smaller.

In the TWENTIETH VERTEBRA (Plate LVIII. figs. 41–43), compared with the nineteenth, the lateral hypapophysial plates (or catapophyses) are still more developed externad, being conspicuous lamellar processes. They do not, however, now reach to the postaxial end of the centrum, but only project out from its preaxial half. The median hypapophysis is shorter dorso-ventrally; but its root now extends to the preaxial margin of the centrum. The postaxial surface of the centrum is less extended transversely.

Compared with the twentieth vertebra of *Phalacrocorax*, the median hypapophysis is very small and postaxiad, while the centrum, instead of being greatly compressed laterally, is extremely flattened ventrally with great lateral hypapophysial processes, the distal ends of which begin to incline somewhat ventrad. The outline of the postaxial articular surface of the centrum is more quadrangular, not rounded, and is less concave. Its sides are concave from the outward extension of the postaxial ends of the lateral hypapophysial ridges.

This vertebra, however, agrees with the corresponding one of *Phalacrocorax* in that in it the præzygapophyses again, for the first time, do not extend so far preaxiad as the preaxial end of the centrum.

The Dorsal Vertebræ.

These vertebræ (Plate LVIII. fig. 46) agree with the dorsal vertebræ of *Phalacrocorax* in being laterally compressed and strongly hypapophysial, or rather catapophysial, since the hypapophyses are differently formed, *i. e.* from medianly coalescing lateral hypapophyses.

The TWENTY-FIRST VERTEBRA differs from the twentieth in that the median hypapophysis has all but disappeared (being only a rudimentary median ridge), while the lateral hypapophyses, though reaching to the postaxial end of the centrum on each side as lateral ridges, yet have their long, outstanding, distally depressed processes confined to a rather smaller extent of the preaxial part of the centrum. The preaxial surface of the centrum is less concave, its postaxial surface more so.

Compared with the same vertebra in *Phalacrocorax*, the preaxial articular surface of the centrum is more quadrangular, the centrum is less compressed laterally and more ventrally flattened. The median hypapophysis has disappeared; but there are conspicuous lateral hypapophyses. The transverse processes project less outward, but are more antero-posteriorly developed. The fossa beneath the root of the transverse process, which is so conspicuous in *Phalacrocorax*, is here wanting.

The TWENTY-SECOND VERTEBRA (Plate LVIII. fig. 44) differs from the twenty-first mainly on its ventral aspect. Its centrum is much more laterally compressed; and the median hypapophysis has quite disappeared; the lateral hypapophyses (already in the last vertebra slightly more ventrad than in the twentieth vertebra) have coalesced medianly under the postaxial half or more of the centrum, while their preaxial ends project outwards, downwards, and backwards, but are much smaller than in the twenty-first vertebra. This vertebra is also more decidedly opisthocœlous than its serial predecessor.

Compared with the same vertebra of *Phalacrocorax*, the centrum is slightly more preaxially convex (especially dorso-ventrally) and postaxially concave. The transverse processes differ much as do those of the twenty-first vertebra. There is no true median hypapophysis; but, as has been said, the lateral hypapophyses bend down and unite to form postaxially a coalesced, vertical, hypapophysial lamellar process.

The TWENTY-THIRD VERTEBRA (Plate LVIII. fig. 45 & Plate LXI. figs. 6, 7, 8, XXIII) differs from its predecessor mainly in that its centrum is still more laterally compressed, and that the lateral hypapophyses have still more completely united medianly, there being now only two small diverging processes at the preaxial end of a median, vertical, subcentral plate, the ventral outline of which is concave antero-posteriorly.

Compared with the same vertebra of *Phalacrocorax*, its centrum is even more laterally compressed; the hypapophysis is also shorter, and, as has been said, its distal preaxial end bifurcates.

The TWENTY-FOURTH VERTEBRA (Plate LXI. figs. 6, 7, 8, XXIV) greatly resembles its predecessor; but its hypapophysial plate scarcely bifurcates at all preaxially, while its ventral margin is more concave antero-posteriorly. It is extremely like the same vertebra of *Phalacrocorax*; and the non-identity in nature of the hypapophysial processes of the two genera would never be suspected were these two vertebræ alone compared without their serial predecessors.

The TWENTY-FIFTH and TWENTY-SIXTH vertebræ are successively smaller and smaller, and have the hypapophysial plate successively simpler and less developed.

They differ from the corresponding vertebræ of *Phalacrocorax* in having the hypapophysial process smaller.

The twenty-sixth vertebra may be devoid of any vertebral rib[1]; but a sternal rib always corresponds with it.

The Lumbar Vertebræ.

These appear to be constantly four in number, with short parapophysial processes ankylosing distally with the ilium, and thus intercepting between them three anterior pelvic foramina on each side. These vertebræ (the TWENTY-SEVENTH, TWENTY-EIGHTH, TWENTY-NINTH, and THIRTIETH) have their centra continuously ossified together and with the last two dorsal, and with the lumbo-sacral, sacral, and sacro-caudal vertebræ. The centra of the lumbar vertebræ gradually broaden postaxially; and though the first has a hypapophysial prominence little less than that of the last dorsal, yet the two most postaxial have a median, ventral, antero-posterior groove. The parapophyses become successively shorter postaxiad. They thus present a general similarity to the lumbar vertebræ of *Phalacrocorax* (Plate LXI. fig. 8).

The Lumbo-sacral Vertebræ.

Of these there may be two or three; they are the THIRTY-FIRST and THIRTY-SECOND VERTEBRÆ of my specimen, which I have taken as my type. They are generally similar to those of *Phalacrocorax*.

The Sacral Vertebræ.

There seem to be constantly two of these vertebræ (the THIRTY-THIRD and THIRTY-FOURTH); but they are less differentiated from the sacro-caudals than is the case in *Phalacrocorax*. Yet the parapophysis does descend decidedly more ventrad than does the transverse process in the anterior sacro-caudal vertebræ. Moreover, as in *Phalacrocorax*, the transverse process of at least the more posterior sacral vertebra forms one continuous whole—a somewhat, though but slightly, vertically extended plate. On the other hand, in the first sacral, the parapophyses may be more or less separated from the diapophysis.

[1] As in the specimen of *Plotus anhinga* in the College of Surgeons' Museum.

The Sacro-caudal Vertebræ.

These are four in number; and the first two seem to be devoid of parapophyses, thus making a more or less marked distinction between them and the sacral vertebræ. Compared with those of *Phalacrocorax*, they are less elongated antero-posteriorly, less laterally compressed as to their centra, with shorter transverse processes.

The Caudal Vertebræ.

There are seven or eight caudal vertebræ, not counting the pygostyle. They resemble those of *Phalacrocorax*; but their parapophyses are not so much bent dorsad, and are more dorsal at their origin in the preaxial vertebræ, descending to a slightly more ventral origin as we proceed postaxiad.

The pygostyle is even more compressed laterally than in *Phalacrocorax*, and thus differs even more than does the latter from the pygostyle of *Sula*. On the other hand, it is much more curved, like the claw of a large *Felis* (Plate LVIII. fig. 47).

The Pelvis.

This bony mass includes fifteen or sixteen vertebræ, extending preaxiad over the twenty-fifth (and sometimes even over part of the twenty-fourth) vertebra. It is very much less elongated, relatively as well as absolutely, than in *Phalacrocorax*, and is shorter, relatively, than even in *Sula*, so as to be a diminutive representation of that of *Pelecanus* as to its general proportions, though in certain details it most nearly approaches the pelvis of *Phalacrocorax*.

Viewed *laterally*, the sacro-ischiatic foramen is seen to be less elongated than in *Phalacrocorax*, and relatively broader dorso-ventrally. The union of the ilium and ischium postaxial to it is short, shorter than in any of the before-described genera except in *Sula*, while the ischium appears relatively deeper dorso-ventrally than in any. The obturator-foramen is also smaller than in any of the other forms. The ilio-caudal spine is long and pointed, as in *Phalacrocorax* (Plate LXI. figs. 6 & 7).

Viewed *dorsally*, the most striking features of the pelvis are the strong, curved posterior iliac ridges which bound the sacral part laterally, which part is relatively wider than in any preceding form save *Pelecanus*. These ridges absolutely distinguish *Plotus* from all the other three genera (Plate LXI. figs. 6 & 7, *lr*).

The antero-posterior length of the preacetabular part of the pelvis, as in *Phalacrocorax*, is much less, compared with that of the postacetabular part, than in *Pelecanus* or *Sula*; and it agrees with that of *Phalacrocorax* in the wing-like lateral expansion of its most preaxial part, and in the strong median ridge.

The ilio-caudal spine projects postaxially little, if at all, beyond the ischium; and the angle formed by it with the adjacent margin of the ischium is less acute.

The external margin of the postaxial half of the ischium is convex, as in *Phalacrocorax*, not concave as in *Sula*.

Seen *ventrally*, the ilia extend out as in *Phalacrocorax*; and there are three presacral foramina (s^1, s^2, s^3) on each side. The lateral acetabular fossæ (*f*) are notably different from those of *Phalacrocorax*, owing to the encroachment inwards of the margins of the acetabula, which almost reduce the preaxial part of each fossa to a narrow chink (Plate LXI. fig. 8).

The ridge running postaxiad inside the ischium is less marked; and there is no such expanse of ilio-ischial surface dorsad of the postaxial part of such ridge as there is in all the other three genera, above all in *Pelecanus*. On the other hand, the expanse of the ischial surface ventrad of the postaxial part of such ridge is greater relatively than even in *Phalacrocorax*, and therefore very much greater than in *Sula* or *Pelecanus*. The pubes do not approximate ventrad as in *Phalacrocorax* or *Sula*.

The Ilium.

The process (*st*) described as existing in *Phalacrocorax* a little postaxial to the antitrochanteric process also exists here, but is nearer to the last-mentioned process. This more postaxial process may be called the posttrochanteric process (Plate LXI. fig. 7).

Besides the points above noted, a ridge runs mediad and preaxiad from this posttrochanteric process, and joins its fellow of the opposite side in the median anteroposterior iliac ridge. Another ridge (*lr*), very much stronger indeed, runs postaxiad from the same process, forming the very prominent ridge of the postacetabular part of the ilium, before noticed. This ridge causes each postacetabular ilium to present three surfaces, one externad, one dorso-mediad, and the other ventro-mediad; and the prominent ridge in question divides the externad from the dorso-mediad surface.

The ilio-pectineal prominence (*lp*) is more sharp and prominent than in any other form of Pelecanidæ.

The Pubis.

This is but a very feeble ossification, and unites with the ischium for a longer space than in the other Pelecanidæ.

The Ischium.

This bone differs from that of the other Pelecanidæ by its greater postaxial expansion dorso-ventrally, presenting an extensive grooved surface (fig. 8, *g*) ventrally, as already noted in describing the ventral aspect of the pelvis.

The Ribs.

There are seven or eight vertebral and six sternal ribs.

The Vertebral Ribs.

The first two belong to the cervico-dorsal vertebræ, and have no corresponding sternal ribs.

The second may or may not have an unciform process; and the same is the case with the seventh rib. The eighth, when present, has no such process.

The last rib has no tubercular process.

The Sternal Ribs.

There are six of these on each side; and the last does not join the sternum, but joins the postaxial side of the penultimate sternal rib. The fourth is a little more than twice as long as the first; and the fifth is a little longer. The second, third, and fourth expand distally to a moderate extent from within outwards (Plate LXI. fig. 9).

The Sternum.

This bone (Plate LXI. figs. 9 & 10) is quite like the corresponding bone of *Phalacrocorax*, except that there are but four distinct articular surfaces on the pleurosteon, while just postaxiad to the pleurosteon an angle (*a*) projects outwards, just internal to which passes the fifth sternal rib. This projecting angle distinguishes the sternum of *Plotus* from that of any other of the Pelecanidæ. The keel approaches the postaxial margin of the sternum more nearly than in *Phalacrocorax* or than in any other of the Pelecanidæ; and the lateral xiphoids are narrower and more pointed.

Besides the four genera described, the two genera *Fregata* and *Phaëton* are usually classed with them to constitute the group of the Steganopodes. But, from the point of view here adopted (that of the postcranial part of the axial skeleton only), I have found it impossible to detect characters which seem to me good and sufficient to unite such Steganopodal group together and at the same time divide them off from other forms. The four genera described, on the other hand, constitute a very natural group (the Pelecanidæ), capable of being characterized by a number of common characters drawn from the postcranial part of the axial skeleton, many of which at the same time will probably serve to mark it off from all other groups of birds.

Fregata and *Phaëton* agreed to differ from the Pelecanidæ as follows:—The cervical vertebræ are only either twelve or thirteen in number, instead of from fifteen to eighteen; the cervical and cervico-dorsal vertebræ together are only fifteen, instead of from seventeen to twenty, as in the Pelecanidæ. There is no distinct sacral vertebra at all, or there is only a rudiment of sacral transverse processes.

In *Fregata* and *Phaëton*, again, the lateral acetabular fossa is enormous, instead of being moderate or small as in the Pelecanidæ. The sacro-sciatic foramen is very small and short. In the Pelecanidæ, except *Phalacrocorax*, there are always hæmal arches to some of the vertebræ, and in the last-named genus such arches are at least nearly completed; but in *Fregata* and *Phaëton* not only are there none, but no tendency to form hæmal arches is exhibited. In the two genera just named the dorsum of the postacetabular part of the ilium is broad and dorsally convex, arching backwards and downwards in a way not found in any of the Pelecanidæ. In that family there is always a marked interval between the lumbar and caudal vertebræ, through the non-development of the parapophyses of some of the vertebræ. In *Fregata* (though not in

Phaëton), on the other hand, there is no such interruption, the transverse processes being continuously developed throughout these vertebræ.

But the most marked distinction obtains with respect to the cervical vertebræ. In all the Pelecanidæ a sudden change takes place in the form of the cervical vertebræ, no vertebra being pressed back at its preaxial end before the eighth or ninth, while the seventh or eighth exhibits, for the first time, serially, a postaxiad forking of its neural arch. In *Fregata* and *Phaëton*, on the other hand, the change in the shape of the vertebræ is gradual, and not sudden, the fifth vertebra being already pressed back postaxiad at its preaxial end, while the same vertebra, or even the fourth, has already its neural arch forking postaxiad, and therefore with a deeply concave postaxial margin to its neural arch. Again, in all the Pelecanidæ the two ilia meet medianly in front of the acetabula and develop a median dorsal ridge, while in *Fregata* they do not nearly meet together medianly in that region at all. In *Phaëton*, though they may appear so to meet, yet they do not do so really, but each ilium has its mediad marginal ridge distant from that of its fellow of the opposite side, though the membrane intervening between the two may become ossified, and so produce a more or less deceptive appearance of similarity to the structure of the Pelecanidæ in this respect. Finally, in the Pelecanidæ there is but a single lateral xiphoid process on each side, while in *Phaëton* there are two on each side, in addition to the median xiphoid process.

For all these reasons I think it better to keep the genera *Fregata* and *Phaëton* apart, and, confining myself here to noticing their great distinctness (with respect to the axial skeleton) from the Pelecanidæ, to reserve any possible consideration of their positive affinities till I come to treat of such group as may appear to exhibit similar characters.

Dr. Brandt, in his paper before referred to, considers the resemblances and affinities of the Steganopodes amongst themselves and with other bird groups. But he bases his estimates upon comparisons of other parts of their anatomy, scarcely making use of characters drawn from the postcranial part of the axial skeleton. It seems to me that though the four genera described form together a very natural group, yet it is difficult to unite together any two of them to the exclusion of the others. Though in some respects *Sula* resembles *Pelecanus* more than the other genera do, yet in other respects *Plotus* and *Pelecanus* are most allied; and while *Sula* and *Phalacrocorax* might from some axial characters be associated together, yet in others (*e. g.* in the number of vertebræ and in the fact that it is the ninth from which its neighbours bend dorsad) *Phalacrocorax* and *Plotus* may claim kinship. On the whole *Plotus* is the most exceptional and differentiated type, and should therefore, I think, form one end of the series, which may be begun with *Pelecanus*, which in some points, at least, appears the least differentiated and most generalized form.

The characters of the four genera, and of the family they compose, may stand as follows:—

CHARACTERS OF THE GENERA.

Pelecanus.

Cervical vertebræ 16, cervico-dorsal 1, together 17; dorsal 5, lumbar 3 or 4, lumbo-sacral 3, sacral 3, sacro-caudal 4, caudal without pygostyle 5 or 6: total 40–42. Vertebral ribs 6, sternal ribs 5. Vertebræ generally swollen and very pneumatic; no long, free styloid processes, such processes merged in lateral subcentral plates; anterior cervical vertebræ elongated; seventh and ninth bend dorsad from eighth; median hypapophyses conspicuous only in fifteenth, sixteenth, and seventeenth vertebræ, and not present in lumbo-sacral or posterior dorsal regions; a hæmal arch to vertebræ from eighth to fourteenth inclusive; faint lateral ridges beneath centra of fifteenth, sixteenth and seventeenth vertebræ; ridges and processes generally obtuse; metapophyses moderate, rather small. Atlas with an odontoid notch and minute hypapophyses. Hypapophyses of axis very small; its hyperapophyses very small; a lateral foramen leading into centrum. Third vertebra with a most rudimentary hypapophysis; lateral vertebral canal long and narrow; hyperapophyses very small; no marked interzygapophysial ridge to third vertebra. Fifth vertebra with a median subcentral groove; sixth vertebra with the same; postzygapophyses more postaxiad in seventh than in sixth vertebra; postaxial margin of neural arch of seventh vertebra very concave, the first (preaxially) to be so. Eighth vertebra the first vertebra pressed back preaxially, with a hæmal arch, with no prominent metapophyses, about equals the seventh in length; styloid processes much as in seventh; præzygapophyses not so preaxiad as centrum; postzygapophyses slightly more postaxiad of centrum than in seventh vertebra. Ninth vertebra but little more pressed back preaxially than eighth; neural spine not more developed in ninth than in eighth vertebra; a hæmal arch present; hyperapophyses in the form of two lateral ridges. Neural spine most prominent in seventh and eighth vertebræ; metapophyses not prominent. Tenth vertebra with a hæmal arch. Postzygapophyses of eleventh vertebra still reach the postaxial end of centrum; in twelfth vertebra the postzygapophyses for the first time fail to extend postaxiad as far as centrum. Thirteenth vertebra with a hæmal arch; fourteenth vertebra with a complete, or nearly complete, hæmal arch. Fifteenth, sixteenth, and seventeenth vertebræ with a median hypapophysis; postero-external angle of centrum not drawn out into a triangular process. Nineteenth vertebra without a hypapophysis, and not laterally compressed. Dorsa of tenth to fourteenth cervical vertebræ flattened, but not presenting a longitudinal groove on each side; no notable lateral compression of the vertebral centra in any region, nor any great ventral flattening; no vertebræ opisthocœlous; parapophyses of second sacral vertebra not stronger than those of first; parapophyses of sacro-caudal vertebræ not suddenly bent dorsad. Broad ilio-caudal process; obturator-foramen oval, broad in proportion to its length; sacro-sciatic foramen not visible when the pelvis is viewed

dorsally, owing to the breadth of the ilia; transverse diameter of pelvis between its antitrochanteric processes nearly double the width of the most preaxial part of ilia; lateral acetabular fossa very large and quadrate; a supraacetabular fossa; pelvis of moderate relative length; postaxial half of external margin of ischium slightly convex; ventral surface of conjoined ischium and ilium extensive; ventral surface of ischium slightly ridged; ischium, external to obturator-foramen, narrow. Pygostyle curved, convex dorsally, with its apex curved postaxiad and ventrad. The vertebral ribs have generally uncinate processes, except the last; last sternal rib expanded proximally. Sternum but little longer than broad; lateral xiphoid processes narrow and pointed; pleurosteon wide, with five articular surfaces.

Sula.

Cervical vertebræ 15, cervico-dorsal 3, together 18; dorsal 6, lumbar 2–4, lumbo-sacral 2 or 3, sacral 1 or 2, sacro-caudal 5 or 6; caudal, without pygostyle, 7: total 43 or 44. Vertebral ribs 9, sternal ribs 6 or 7. Vertebræ generally but little swollen or pneumatic; styloid processes free, rather long and rather stout; anterior cervical vertebræ all short; seventh and ninth bent dorsad from eighth; hypapophyses of first, second, third, and fourth vertebræ large, and small ones to seventeenth and eighteenth vertebræ; none present in posterior dorsal or lumbo-sacral region; hæmal arches to vertebræ from the ninth or tenth to the thirteenth; no lateral ridges beneath fifteenth to twenty-sixth vertebræ; ridges and processes generally sharp; metapophyses relatively very large. Atlas with an odontoid foramen and bony hypapophysis; axis with very long hypapophysis, large hyperapophyses, and lateral foramen leading into centrum; third vertebra with very long hypapophysis, short and wide lateral vertebral canal, much larger hyperapophyses than in *Pelecanus*, and very marked interzygapophysial ridges; fifth and sixth vertebræ with a median subcentral groove; postzygapophyses of seventh vertebra not more postaxiad than those of sixth; postaxial margin of neural arch of seventh vertebra not very concave, the first (preaxially) deeply concave behind being that of the eighth vertebra. Eighth vertebra more pressed back preaxially than the seventh of *Pelecanus*, but less so than the eighth of *Pelecanus*; it is the first which is pressed back preaxially; eighth vertebra about as long as the seventh, with no hæmal arch, but with prominent metapophyses; styloid processes rather larger than in the seventh vertebra, which has its præzygapophyses slightly more preaxiad, and postzygapophyses decidedly more postaxiad than centrum. Ninth vertebra much more pressed back preaxially than the eighth, and the first one very much pressed back, and in its development intermediate between the eighth and the ninth vertebræ of *Pelecanus*; its neural spine much more developed than that of the eighth vertebra generally, with no hæmal arch; its hyperapophyses two sharp lateral processes; neural spine most prominent in the ninth vertebra of all the cervical vertebræ; its metapophyses very long and sharp processes. Tenth vertebra with a

hæmal arch. The postzygapophyses of the eleventh vertebra hardly reach, if they do reach, the postaxial end of its centrum; the postzygapophyses of the twelfth vertebra fail decidedly to extend postaxiad as far as the centrum. Thirteenth vertebra with a hæmal arch; but this part is suddenly wanting in fourteenth; fifteenth, sixteenth, and seventeenth vertebræ with only a slight median ridge instead of a marked hypapophysis; postero-external angles of centrum of eighteenth vertebra not drawn out into triangular processes; nineteenth vertebra without a hypapophysis, and only slightly compressed laterally. Dorsa of tenth to fourteenth cervical vertebræ not even much flattened, and therefore certainly not antero-posteriorly grooved. No notable lateral compression of vertebral centra, but most developed in from twenty-first to twenty-fifth vertebræ; vertebræ fourteenth to seventeenth flattened beneath; no vertebræ opisthocœlous; parapophyses of second sacral vertebra very much stronger than those of the first; parapophyses of sacro-caudal vertebræ suddenly bent dorsad. Ilio-caudal processes either truncated or pointed; obturator-foramen oval, relatively longer than in *Pelecanus*; sacro-sciatic foramina visible when the pelvis is viewed dorsally; transverse diameter of pelvis between its antitrochanteric processes only slightly in excess of that of most preaxial part of ilia; lateral acetabular fossæ considerable and triangular; no supraacetabular fossæ; pelvis of moderate length; postaxial half of external margins of ischium concave; ventral surface of conjoined ischium and ilium very small; ventral surface of the ischium strongly ridged; ischium, external to obturator-foramen, narrow. Pygostyle long, prismatic, ventrally flattened, and with a strong dorsal ridge; its ventral margin strongly concave. All but the last two long vertebral ribs with uncinate processes; last sternal ribs not expanded proximally. Sternum more than twice as long as broad; lateral xiphoid processes somewhat spatulate; pleurosteon more narrowed dorso-ventrally than in *Pelecanus*, but with five articular surfaces.

Phalacrocorax.

Cervical vertebræ 17 or 18, cervico-dorsal 3 or 2, together 20; dorsal 5, lumbar 4 or 5, lumbo-sacral 1–3, sacral 1 or 2, sacro-caudal 7 or 8; caudal, without pygostyle, 5–8: total 46–49. Vertebral ribs 7 or 8, sternal ribs 5. Vertebræ generally but little swollen or pneumatic; styloid processes long and very slender; anterior cervical vertebræ rather shorter relatively than in *Pelecanus*; eighth and tenth vertebræ bend dorsad from ninth; hypapophyses large in the first to fourth and fourteenth to twenty-seventh vertebræ, large in dorsal aud lumbo-sacral regions; neural spine most prominent in the seventh, eighth, and ninth of all the cervical vertebræ; no vertebra with a complete hæmal arch; no lateral ridges beneath fifteenth to twenty-sixth vertebræ; ridges and processes generally very sharp; metapophyses relatively very large and prominent indeed. Atlas with an odontoid foramen, and with three hypapophyses; axis with very long hypapophysis, moderate hyperapophyses, and no lateral foramen leading into centrum; third vertebra with very long hypapophysis, wide and very short lateral

canal, large and much pointed hyperapophyses, and with only slightly marked interzygapophysial ridges; fifth and sixth vertebræ not grooved beneath, but with a median ridge; postzygapophyses of seventh vertebra not more postaxiad than those of sixth; postaxial margin of neural arch of seventh vertebra not very concave, the first (preaxially) deeply concave behind being that of the eighth vertebra; eighth vertebra about as long as the seventh, with no hæmal arch, but with very prominent and rugged metapophyses, with styloid processes rather longer than in the seventh vertebra, and with præzygapophyses much more preaxiad, and postzygapophyses rather more postaxiad than the centrum. Ninth vertebra, and the first one which is *at all* pressed back preaxially; it is like the eighth of *Pelecanus*; its neural spine not so much developed as that of the eighth vertebra, and always with no hæmal arch; its hyperapophyses two very sharp lateral processes; its metapophyses sharp and long, but not so much as those of *Sula*. Tenth vertebra with no hæmal arch; the postzygapophyses of the eleventh vertebra fail, for the first time, decidedly to reach the postaxial end of centrum (therefore both zygapophyses fall short of antero-posterior limits of centrum); thirteenth vertebra with no hæmal arch, but the catapophyses almost form one; a long median hypapophysis suddenly appears on the fourteenth vertebra; fifteenth, sixteenth, and seventeenth vertebræ with large, median, plate-like hypapophyses; postero-external angles of centrum of eighteenth vertebra drawn out into triangular processes; nineteenth vertebra with a long narrow hypapophysis, and with its centrum laterally compressed; dorsa of tenth to nineteenth cervical vertebræ not even much flattened, and therefore certainly not antero-posteriorly grooved; great lateral compression in centra of nineteenth to twenty-seventh vertebræ; sixteenth, seventeenth, and eighteenth vertebræ expanded and flattened beneath in spite of the presence of a hypapophysis; twentieth to twenty-fourth vertebræ opisthocœlous; parapophyses of second sacral vertebra not much, if at all, stronger than those of the first; parapophyses of sacro-caudal vertebræ rather suddenly bent dorsad. Ilio-caudal processes long and pointed; obturator foramen oval, still longer than in *Sula*; sacro-sciatic foramina visible when the pelvis is viewed dorsally; transverse diameter of pelvis, between its antitrochanteric processes, falling short of that of the most preaxial part of the ilia; each lateral acetabular fossa small, and shaped as a parallelogram; no supraacetabular fossa; pelvis very elongated; postaxial half of external margin of ischium strongly convex; ventral surface of conjoined ischium and ilium extensive; ventral surface of ischium very strongly ridged; ischium, external to obturator-foramen, narrow. Pygostyle bent up dorsad, and shaped like the claw of a feline mammal. All the long vertebral ribs except the last with an uncinate process; last sternal ribs not expanded proximally. Length of sternum exceeding its breadth but little more than in *Pelecanus*; lateral xiphoid processes rather broad, but pointed; pleurosteon much narrower dorso-ventrally than in *Pelecanus*, and with only four articular surfaces.

PLOTUS.

Cervical vertebræ 18, cervico-dorsal 2, together 20; dorsal 5 or 6, lumbar 4, lumbo-sacral 2 or 3, sacral 2, sacro-caudal 4; caudal, without pygostyle, 7 or 8: total 45 or 46. Vertebral ribs 7 or 8, sternal ribs 6. Vertebræ generally but little swollen or pneumatic; styloid processes short in the more anterior vertebræ, but enormous in the eighth, and long in the four or five succeeding vertebræ; anterior cervical vertebræ very long, and increasing in length to the eighth; eighth and tenth vertebræ bending dorsad from ninth; hypapophyses present in the first and in from the fifteenth to the twentieth vertebræ; in twenty-third to twenty-sixth vertebræ a median subcentral process of peculiar nature; a complete hæmal arch in ninth to fourteenth vertebræ; strong lateral ridges on centra of seventeenth to twenty-sixth vertebræ, bent down in twenty-second to twenty-sixth; ridges and processes generally rather sharper than in *Sula*; metapophyses as sharp as in *Phalacrocorax*, but smaller. Atlas with a very small odontoid process and one median hypapophysis; axis with the merest rudiment of a hypapophysis, small hyperapophyses, and no lateral foramen leading into centrum; third and fourth vertebræ with no hypapophysis, no lateral canal, no interzygapophysial ridge, and hyperapophyses slightly larger relatively than in *Pelecanus*; fifth and sixth vertebræ medianly grooved beneath; postzygapophyses of seventh vertebra not more postaxiad than in the sixth; postaxial margin of neural arch of seventh vertebra not concave, this concavity first appearing in the eighth, and there very slight; eighth vertebra not pressed back preaxially (the ninth the first to be so pressed back), half as long again as seventh, with no hæmal arch, with rugged but not very prominent metapophyses, and with styloid processes enormously longer than those of seventh vertebra, with præzygapophyses much more preaxiad than centrum, and with postzygapophyses not quite so postaxiad as centrum, but very much less postaxiad than in seventh vertebra; neural spine prominent in seventh and eighth vertebræ. Ninth vertebra pressed back to an enormous degree; it is thus parallel to the eighth of *Pelecanus*; its neural spine not so much developed as that of eighth; ninth vertebra with a hæmal arch, and the first to have one; its hyperapophyses two lateral sharp processes, which may be so continued as to form a dorsal arch on each side of the vertebra, or else they help to give attachment to such a fibrous arch; the metapophyses mere ridges; tenth vertebra with a hæmal arch; the postzygapophyses of the eleventh vertebra do not quite reach the postaxial end of the centrum; but they do not fail to do so for the first time, because they so fail in the eighth (though not in the tenth) vertebra; postzygapophyses of twelfth vertebra fail very decidedly to reach the postaxial end of the centrum; thirteenth vertebra with a hæmal arch; fourteenth vertebra the last with a hæmal arch. A large, median, plate-like hypapophysis suddenly appears in the fifteenth vertebra, and is still larger in the sixteenth; it is small and postaxial in the

seventeenth vertebra; postero-external angles of centrum of eighteenth vertebra extensive, and extending more preaxiad than in *Phalacrocorax*. Nineteenth vertebra with a small hypapophysis; centrum not at all laterally compressed, but ventrally flattened. Dorsa of tenth to fourteenth vertebræ form a longitudinal groove; great lateral compression in centra of twenty-second to twenty-sixth vertebræ; seventeenth to twenty-first vertebræ flattened beneath; twenty-second to twenty-fifth vertebræ opisthocœlous; parapophyses of second sacral vertebra not stronger than those of first; parapophyses of sacro-caudal vertebræ rather suddenly bent dorsad. Ilio-caudal processes long and pointed; obturator-foramen shorter and rounder than in the three preceding genera; sacro-sciatic foramina hidden when the pelvis is viewed dorsally, because of the length of the transverse processes of the sacro-caudal vertebræ, which extend the ilium so much outwards on each side; transverse diameter of pelvis between its antitrochanteric processes falls short of that of the most preaxial part of the ilia; lateral acetabular fossæ small and triangular; no supraacetabular fossa; pelvis rather short; postaxial half of external margin of ischium strongly convex; ventral surface of conjoined ischium and ilium rather extensive; ventral surface of ischium very slightly ridged; ischium, external to obturator-foramen, broad. Pygostyle much laterally compressed and dorso-ventrally curved. All the long vertebral ribs with an uncinate process, except the last rib; last sternal rib not expanded proximally. Length of sternum exceeding its breadth but little more than in *Pelecanus*; lateral xiphoid processes narrow, long, and pointed; pleurosteon much narrower dorso-ventrally than in *Pelecanus* and with only four articular surfaces.

Characters of the Pelecanidæ.

Cervical vertebræ 15–18, cervico-dorsal 1–3, together 17–20; dorsal 5 or 6, prelumbar 22–26, lumbar 3–5, together 8–10; cervical to lumbar inclusive 25–30, lumbo-sacral 1–3, lumbar and lumbo-sacral 5–7, sacral 1–3, sacro-caudal 4–8, caudal 5–8, sacral to caudal inclusive but without pygostyle 13–18: total 40–49. Vertebral ribs 6–9; sacral ribs 5–7. A sudden change of form arising in either eighth or ninth vertebra, such vertebra being pressed back postaxiad at its preaxial end, and having both the vertebra in front and behind it bent dorsad from it; neural arch of seventh or eighth vertebra suddenly deeply concave at its hinder margin, save in *Plotus*; median hypapophysis always to seventeenth vertebra, and possibly present from fourteenth to twenty-seventh vertebra; always a complete, or nearly complete, hæmal arch to two or three vertebræ, and generally complete from tenth to thirteenth vertebræ, sometimes from eighth to fourteenth; metapophyses often long and pointed; atlas generally with an odontoid foramen, sometimes with an odontoid groove; neural spine prominent in seventh to ninth vertebræ; postzygapophyses fail to attain the postaxial end of the centrum, for the first time, in from eighth to twelfth vertebræ; twentieth to

twenty-fifth vertebræ may be opisthocœlous; a median subvertebral process may be formed, of bent-down lateral hypapophyses conjoined, as in *Plotus*; lateral acetabular fossa subtriangular or quadrate, but never enormous in size; supraacetabular fossa present or absent; always a marked interval between lumbar and caudal vertebræ through non-development of parapophyses; sacral vertebræ distinct or not so. Pelvis including from fifteen to seventeen vertebræ; ilia not meeting at an acute angle; no conspicuous ilio-pectineal processes; ilia not flattened against the postacetabular vertebræ; acetabula, preaxiad to the antero-posterior middle of the pelvis; ischia and ilia largely united postaxially; pelvis more vertically extended behind than in front of acetabula; postacetabular part of pelvis broader transversely than the preacetabular part; ilio-caudal spine present or absent; preacetabular parts of ilia meeting in a median dorsal ridge; dorsum of postacetabular part of ilium not high, convex and broad. Sternum twice as long as broad, or else but very little longer than broad; furcula ankylosed or not; only one lateral xiphoid process on each side.

DESCRIPTION OF THE PLATES.

(In Plates LV., LVI., LVII., & LVIII., the following letters have throughout the meanings here given.)

ac. Preaxial surface of centrum.
az. Præzygapophysis.
c. Catapophysis.
c'. Ridge extending postaxially from catapophysis.
cg. Groove internal to catapophysial ridge.
d. Diapophysis.
f. Foramen in catapophysial ridge.
g. Groove external to catapophysial ridge.
h. Surface for head of rib.
hp. Hyperapophysis.
hp'. Small process, preaxial to hyperapophysis.
hy. Hypapophysis.
hy'. Lateral parapophysial ridge.
iz. Interzygapophysial ridge.
m. Metapophysis.
ns. Neural spine.
o. Odontoid process.
of. Foramen for odontoid process.
p. Parapophysis.

p'. Parapophysial ridge.
pc. Postaxial surface of centrum.
pl. Pleurapophysial lamella.
ps. Styliform process.
pz. Postzygapophysis.
t. Surface for tubercle of rib.
v. Lateral canal.
z. Zygapophysis of atlas.

PLATE LV.

VERTEBRÆ OF *Pelecanus*.

Fig. 1. Atlas vertebra, seen preaxially.
Fig. 2. Atlas vertebra, seen laterally.
Fig. 3. Axis vertebra, seen laterally.
Fig. 4. Third vertebra, seen laterally.
Fig. 5. Fifth vertebra, seen ventrally.
Fig. 6. Sixth vertebra, seen laterally.
Fig. 7. Sixth vertebra, seen dorsally.
Fig. 8. Sixth vertebra, seen ventrally.
Fig. 9. Seventh vertebra, seen laterally.
Fig. 10. Seventh vertebra, seen dorsally.
Fig. 11. Seventh vertebra, seen ventrally.
Fig. 12. Seventh vertebra, seen preaxially.
Fig. 13. Eighth vertebra, seen laterally.
Fig. 14. Eighth vertebra, seen dorsally.
Fig. 15. Eighth vertebra, seen ventrally.
Fig. 16. Eighth vertebra, seen preaxially.
Fig. 17. Eighth vertebra, seen postaxially.
Fig. 18. Ninth vertebra, seen laterally.
Fig. 19. Ninth vertebra, seen dorsally.
Fig. 20. Ninth vertebra, seen ventrally.
Fig. 21. Ninth vertebra, seen preaxially.
Fig. 22. Thirteenth vertebra, seen dorsally.
Fig. 23. Thirteenth vertebra, seen ventrally.
Fig. 24. Thirteenth vertebra, seen preaxially.
Fig. 25. Fifteenth vertebra, seen laterally.
Fig. 26. Fifteenth vertebra, seen dorsally.
Fig. 27. Fifteenth vertebra, seen ventrally.
Fig. 28. Fifteenth vertebra, seen preaxially.
Fig. 29. Fifteenth vertebra, seen postaxially.

PLATE LVI.

VERTEBRÆ OF *Sula*.

Fig. 1. Atlas vertebra, seen preaxially.
Fig. 2. Atlas vertebra, seen laterally.
Fig. 3. Axis vertebra, seen laterally.
Fig. 4. Third vertebra, seen laterally.
Fig. 5. Fifth vertebra, seen ventrally.
Fig. 6. Sixth vertebra, seen laterally.
Fig. 7. Sixth vertebra, seen dorsally.
Fig. 8. Sixth vertebra, seen ventrally.
Fig. 9. Seventh vertebra, seen laterally.
Fig. 10. Seventh vertebra, seen dorsally.
Fig. 11. Seventh vertebra, seen ventrally.
Fig. 12. Seventh vertebra, seen preaxially.
Fig. 13. Eighth vertebra, seen laterally.
Fig. 14. Eighth vertebra, seen dorsally.
Fig. 15. Eighth vertebra, seen ventrally.
Fig. 16. Eighth vertebra, seen preaxially.
Fig. 17. Eighth vertebra, seen postaxially.
Fig. 18. Ninth vertebra, seen laterally.
Fig. 19. Ninth vertebra, seen dorsally.
Fig. 20. Ninth vertebra, seen ventrally.
Fig. 21. Ninth vertebra, seen preaxially.
Fig. 22. Tenth vertebra, seen laterally.
Fig. 23. Tenth vertebra, seen dorsally.
Fig. 24. Tenth vertebra, seen preaxially.
Fig. 25. Fifteenth vertebra, seen dorsally.
Fig. 26. Fifteenth vertebra, seen ventrally.
Fig. 27. Fifteenth vertebra, seen laterally.
Fig. 28. Fifteenth vertebra, seen preaxially.

PLATE LVII.

VERTEBRÆ OF *Phalacrocorax*.

Fig. 1. Atlas vertebra, seen preaxially,
Fig. 2. Atlas vertebra, seen laterally,
Fig. 3. Atlas vertebra, seen ventrally.
} once and a half the natural size.

Fig. 4. Axis vertebra, seen laterally, natural size.

Fig. 5. Axis vertebra, seen ventrally.
Fig. 6. Third vertebra, seen laterally.
Fig. 7. Third vertebra, seen ventrally.
Fig. 8. Seventh vertebra, seen laterally.
Fig. 9. Seventh vertebra, seen dorsally.
Fig. 10. Seventh vertebra, seen ventrally.
Fig. 11. Seventh vertebra, seen preaxially.
Fig. 12. Eighth vertebra, seen laterally.
Fig. 13. Eighth vertebra, seen dorsally.
Fig. 14. Eighth vertebra, seen ventrally.
Fig. 15. Eighth vertebra, seen preaxially.
Fig. 16. Eighth vertebra, seen postaxially.
Fig. 17. Ninth vertebra, seen laterally.
Fig. 18. Ninth vertebra, seen dorsally.
Fig. 19. Ninth vertebra, seen ventrally.
Fig. 20. Ninth vertebra, seen preaxially.
Fig. 21. Tenth vertebra, seen laterally.
Fig. 22. Tenth vertebra, seen dorsally.
Fig. 23. Tenth vertebra, seen preaxially.
Fig. 24. Twelfth vertebra, seen laterally.
Fig. 25. Fifteenth vertebra, seen laterally.
Fig. 26. Fifteenth vertebra, seen dorsally.
Fig. 27. Fifteenth vertebra, seen ventrally.
Fig. 28. Fifteenth vertebra, seen preaxially.
Fig. 29. Fifteenth vertebra, seen postaxially.
Fig. 30. Eighteenth vertebra, seen laterally.
Fig. 31. Nineteenth vertebra, seen laterally.
Fig. 32. Nineteenth vertebra, seen preaxially.
Fig. 33. Nineteenth vertebra, seen postaxially.
Fig. 34. Twentieth vertebra, seen laterally.
Fig. 35. Twentieth vertebra, seen preaxially.
Fig. 36. Twentieth vertebra, seen postaxially.
Fig. 37. Twenty-first vertebra, seen laterally.
Fig. 38. Twenty-first vertebra, seen preaxially.
Fig. 39. Twenty-first vertebra, seen postaxially.
Fig. 40. Twenty-second vertebra, seen laterally.
Fig. 41. Twenty-second vertebra, seen preaxially.
Fig. 42. Twenty-second vertebra, seen postaxially.
Fig. 43. Twenty-third vertebra, seen laterally.
Fig. 44. Twenty-third vertebra, seen preaxially.
Fig. 45. Twenty-third vertebra, seen postaxially.

PLATE LVIII.

VERTEBRÆ OF *Plotus*.

Fig. 1. Atlas vertebra, seen preaxially, } twice the natural size.
Fig. 2. Atlas vertebra, seen laterally, }
Fig. 3. Axis vertebra, seen laterally, the size of nature.
Fig. 4. Axis vertebra, seen ventrally.
Fig. 5. Third vertebra, seen laterally.
Fig. 6. Third vertebra, seen ventrally.
Fig. 7. Fourth vertebra, seen laterally.
Fig. 8. Fourth vertebra, seen ventrally.
Fig. 9. Fifth vertebra, seen laterally.
Fig. 10. Fifth vertebra, seen dorsally.
Fig. 11. Fifth vertebra, seen ventrally.
Fig. 12. Sixth vertebra, seen laterally.
Fig. 13. Sixth vertebra, seen dorsally.
Fig. 14. Sixth vertebra, seen ventrally.
Fig. 15. Seventh vertebra, seen laterally.
Fig. 16. Seventh vertebra, seen dorsally.
Fig. 17. Seventh vertebra, seen ventrally.
Fig. 18. Eighth vertebra, seen laterally.
Fig. 19. Eighth vertebra, seen dorsally.
Fig. 20. Eighth vertebra, seen ventrally.
Fig. 21. Eighth vertebra, seen preaxially.
Fig. 22. Eighth vertebra, seen postaxially.
Fig. 23. Ninth vertebra, seen laterally.
Fig. 24. Ninth vertebra, seen dorsally.
Fig. 25. Ninth vertebra, seen ventrally.
Fig. 26. Ninth vertebra, seen preaxially.
Fig. 27. Ninth vertebra, seen postaxially.
Fig. 28. Tenth vertebra, seen laterally.
Fig. 29. Tenth vertebra, seen dorsally.
Fig. 30. Tenth vertebra, seen preaxially.
Fig. 31. Eleventh vertebra, seen laterally.
Fig. 32. Eleventh vertebra, seen ventrally.
Fig. 33. Twelfth vertebra, seen laterally.
Fig. 34. Fifteenth vertebra, seen laterally.
Fig. 35. Fifteenth vertebra, seen dorsally.
Fig. 36. Fifteenth vertebra, seen preaxially.

Fig. 37. Eighteenth vertebra, seen laterally.
Fig. 38. Eighteenth vertebra, seen ventrally.
Fig. 39. Nineteenth vertebra, seen laterally.
Fig. 40. Nineteenth vertebra, seen ventrally.
Fig. 41. Twentieth vertebra, seen ventrally.
Fig. 42. Twentieth vertebra, seen preaxially.
Fig. 43. Twentieth vertebra, seen postaxially.
Fig. 44. Twenty-second vertebra, seen postaxially.
Fig. 45. Twenty-third vertebra, seen preaxially.
Fig. 46. Twenty-first, twenty-second, twenty-third, and twenty-fourth vertebræ together, seen ventrally.
Fig. 47. Caudal vertebræ and pygostyle.

(In Plates LIX., LX., & LXI., the following letters have throughout the meanings here given.)

a. Sternal angle postaxial to pleurosteon (*Plotus*).
at. Antitrochanteric process.
c. Coracoid groove of sternum.
ca. Costal angle of sternum.
cl. Root of furculum.
f. Lateral acetabular fossa.
f'. Supraacetabular fossa (*Pelecanus*).
g. Groove on ventral surface of ischium.
gl. Gluteal ridge.
h. Surface for head of rib.
i. Ischium.
il. Ilium.
il'. Postacetabular part of ilium.
k. Keel of sternum.
lc. Ilio-caudal spine.
lp. Ilio-pectineal eminence.
lr. Ridge postaxial to posttrochanteric process (*Plotus*).
lx. Lateral xiphoid.
mx. Median xiphoid.
p. Pubis.
ps. Ventral process of ischium.
s^1., *s*^{2}., *s*^{3}. Sacral foramina.
st. Posttrochanteric process.
t. Surface for tubercle of rib.

PLATE LIX.

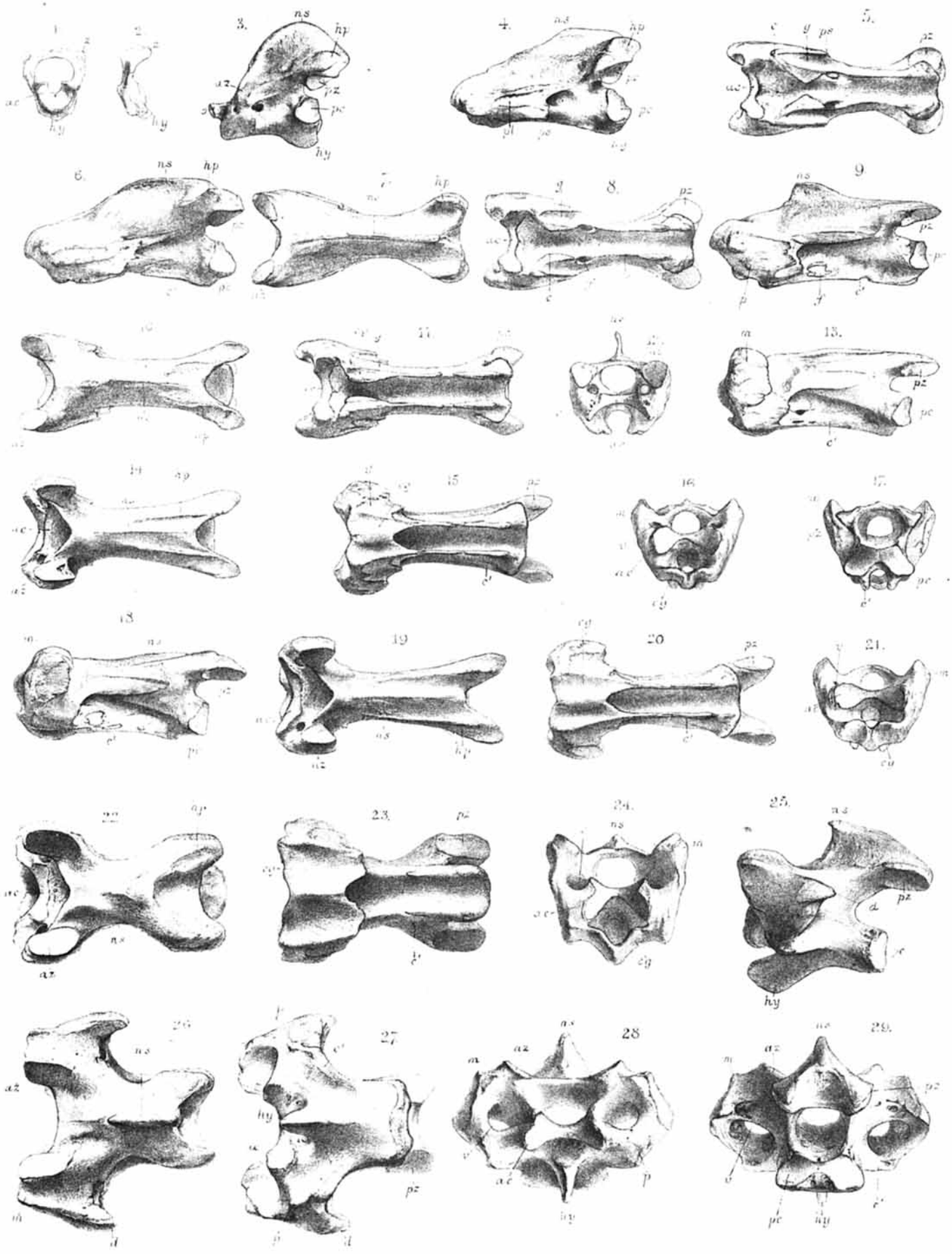
Fig. 1. Dorsal view of pelvis of *Pelecanus*.
Fig. 2. Lateral view of pelvis of *Pelecanus*.
Fig. 3. Ventral view of pelvis of *Pelecanus*.
Fig. 4. Lateral view of sternum of *Pelecanus*.
Fig. 5. Ventral view of sternum of *Pelecanus*.
Fig. 6. Caudal vertebræ and pygostyle of *Pelecanus*.
Fig. 7. Pygostyle of *Sula*.

PLATE LX.

Fig. 1. Dorsal view of pelvis of *Sula*.
Fig. 2. Lateral view of pelvis of *Sula*.
Fig. 3. Ventral view of pelvis of *Sula*.
Fig. 4. Lateral view of sternum of *Sula*. (The sixth sternal rib is not represented.)
Fig. 5. Ventral view of sternum of *Sula*.
Fig. 6. Lateral view of pelvis of *Phalacrocorax*.

PLATE LXI.

Fig. 1. Ventral view of pelvis of *Phalacrocorax*.
Fig. 2. Dorsal view of pelvis of *Phalacrocorax*.
Fig. 3. Lateral view of sternum of *Phalacrocorax*.
Fig. 4. Ventral view of sternum of *Phalacrocorax*.
Fig. 5. Some caudal vertebræ and pygostyle of *Phalacrocorax*.
Fig. 6. Lateral view of pelvis of *Plotus*.
Fig. 7. Dorsal view of pelvis of *Plotus*.
Fig. 8. Ventral view of pelvis of *Plotus*.
Fig. 9. Lateral view of sternum of *Plotus*.
Fig. 10. Ventral view of sternum of *Plotus*.



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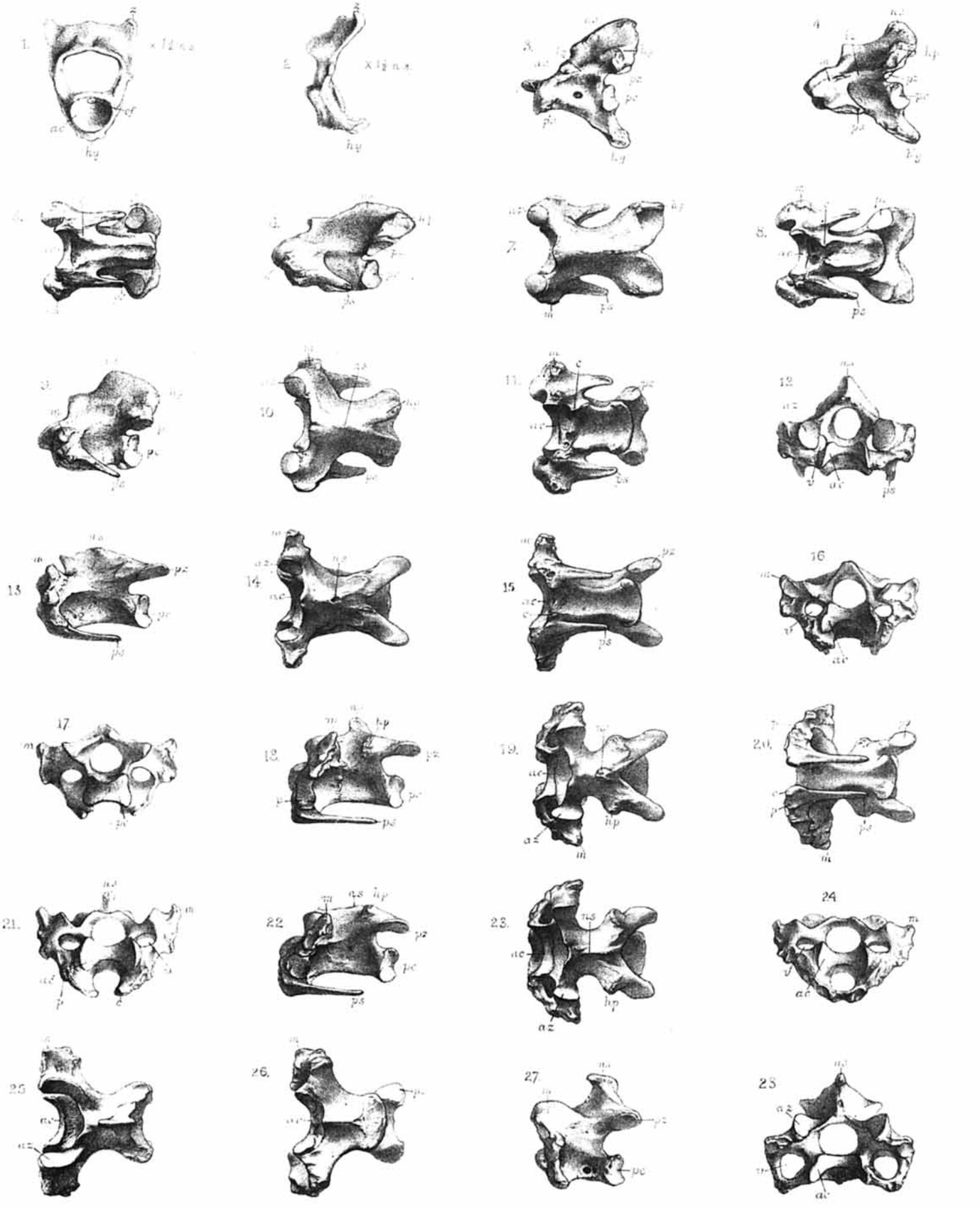
AXIAL SKELETON OF THE PELECANIDÆ.



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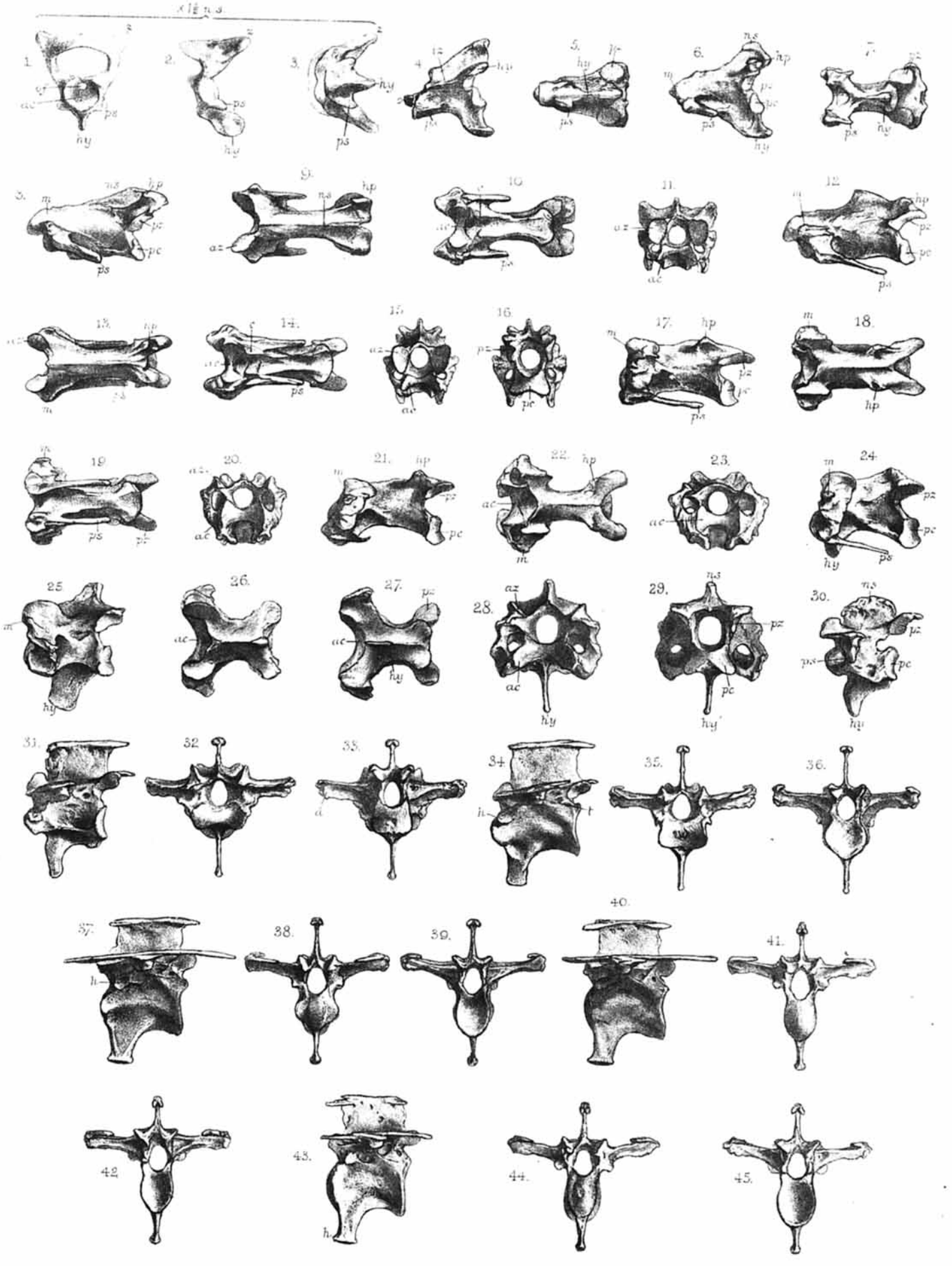

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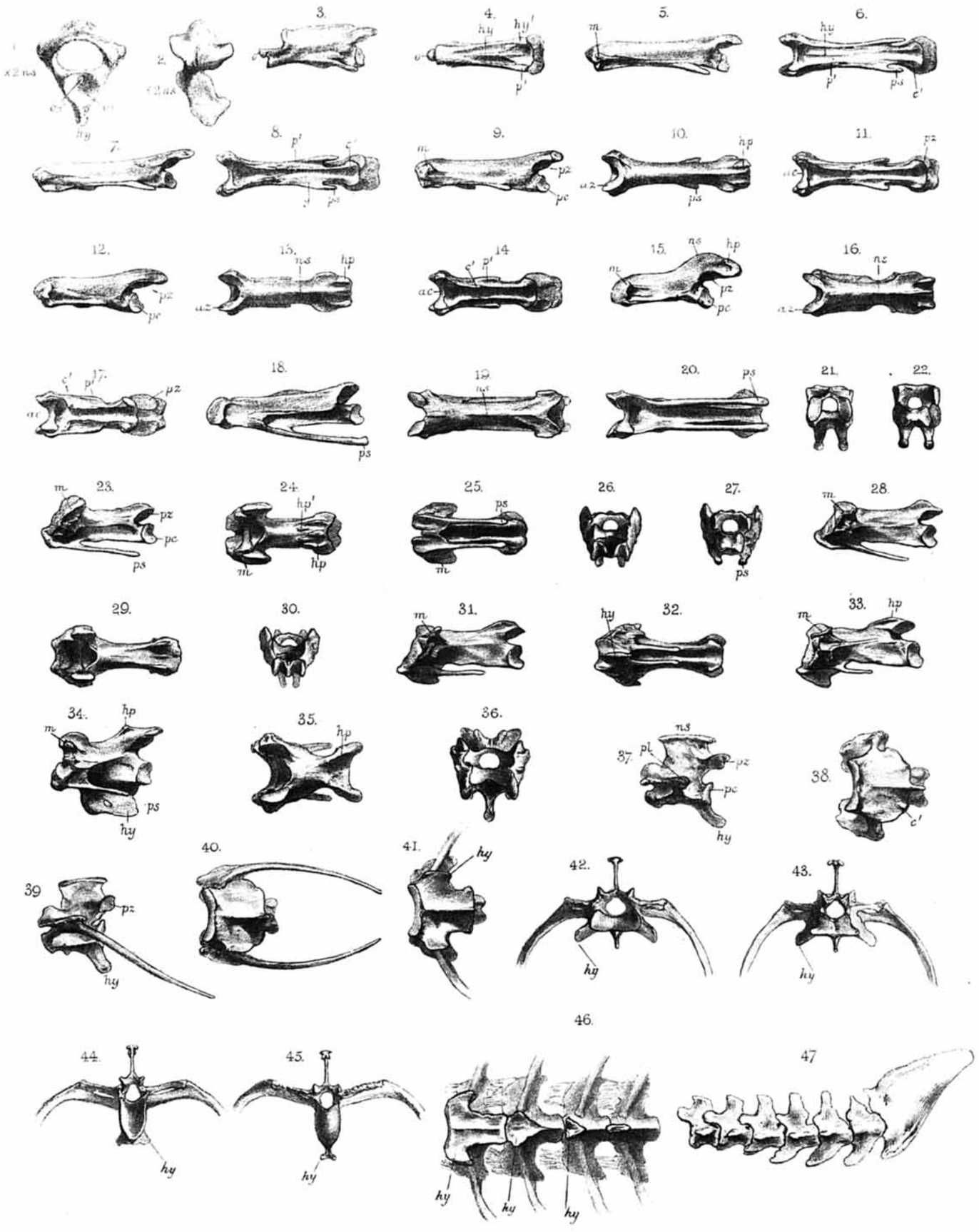

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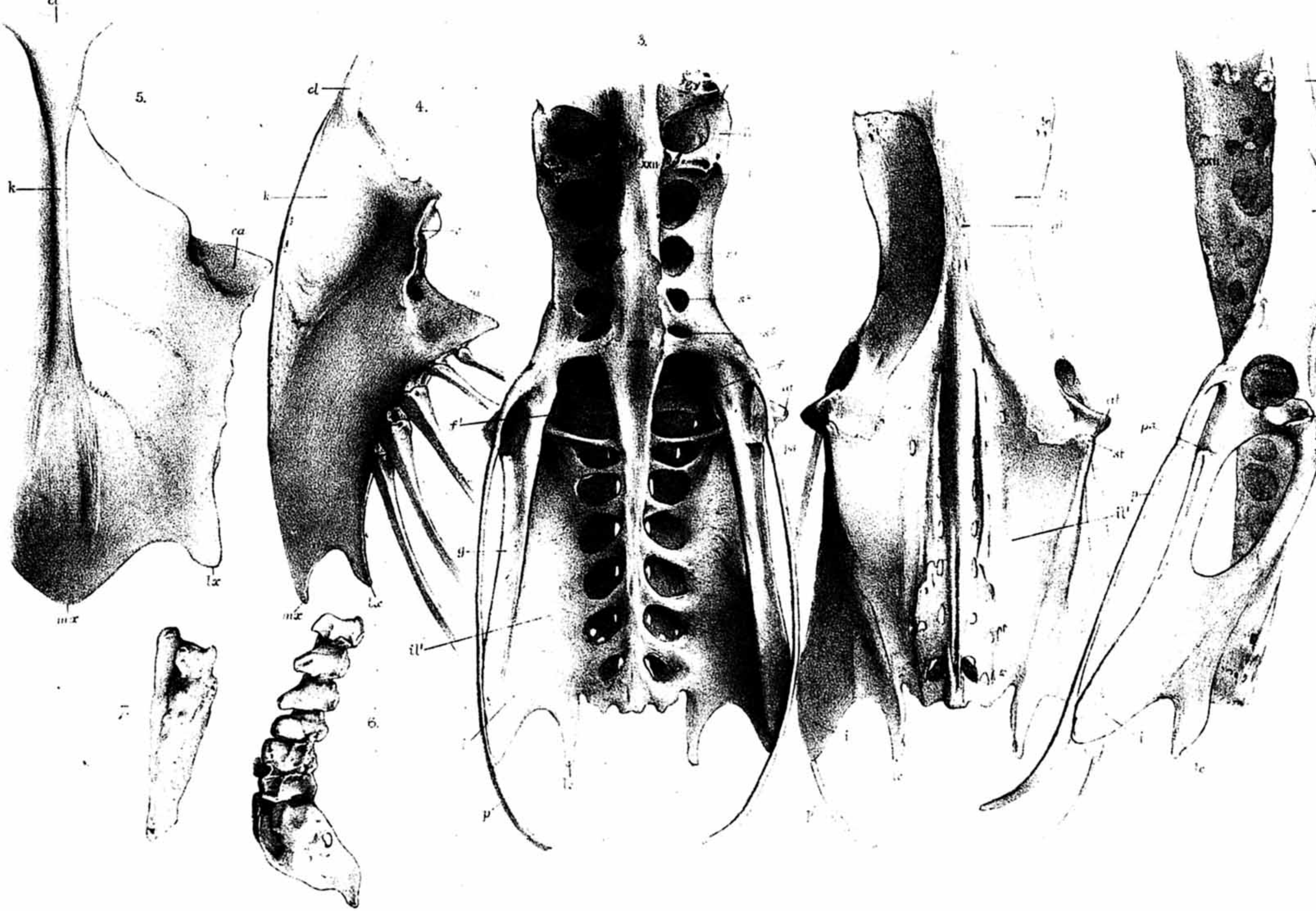

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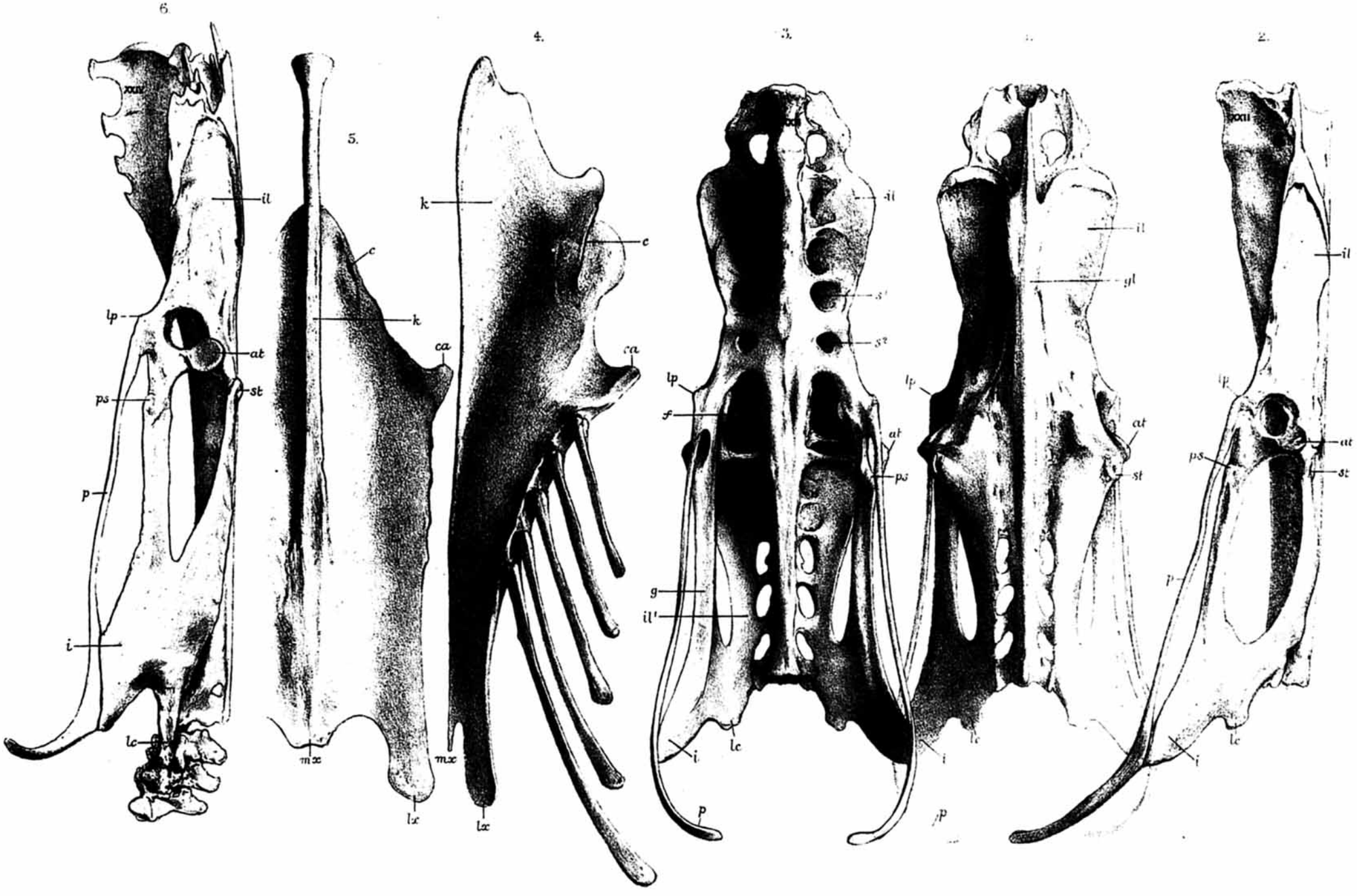

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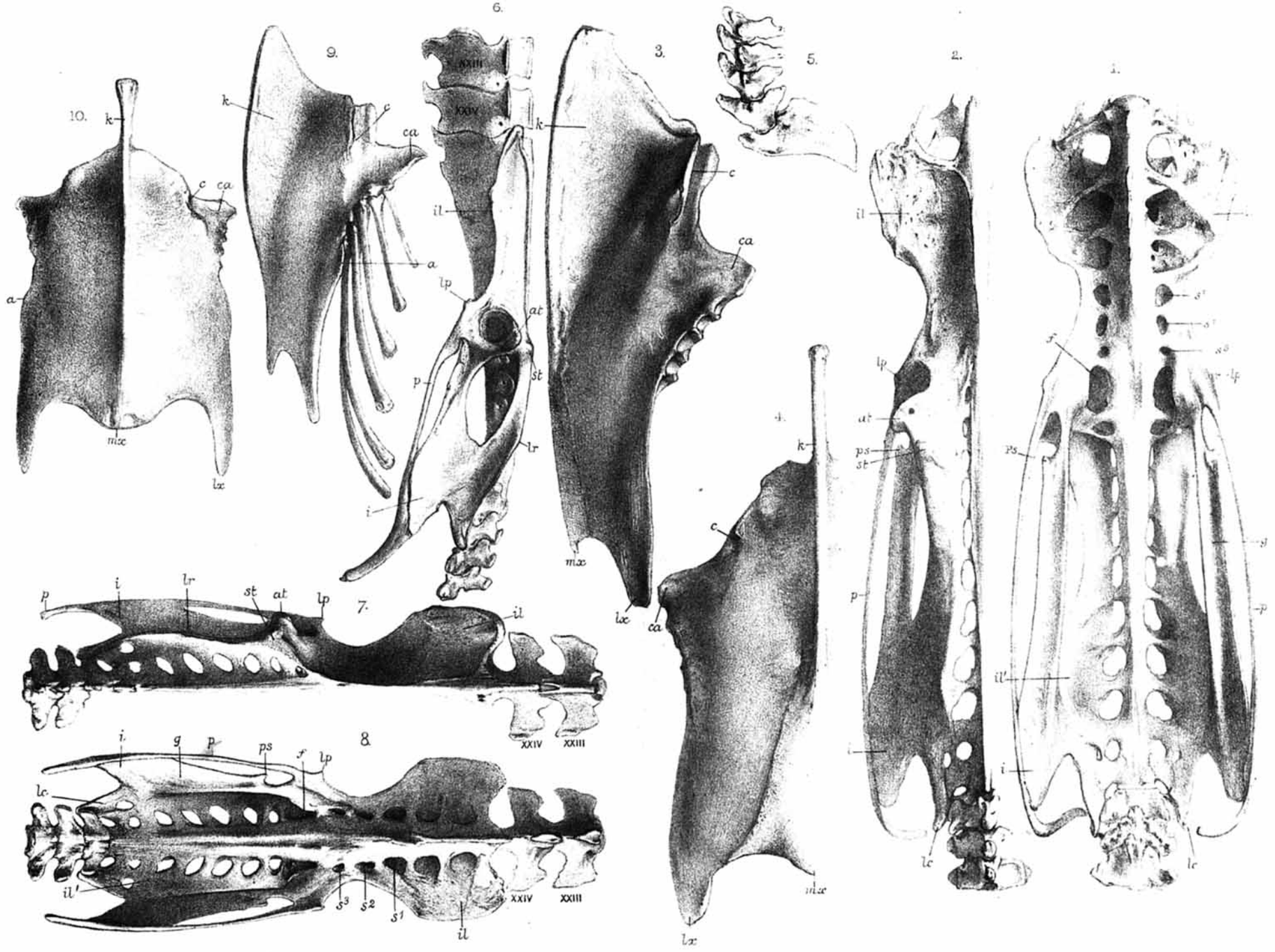

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AXIAL SKELETON OF THE PELECANIDÆ.