III. *Additional Observations on the Development of Apteryx.*

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[Plates 7, 8.]

Contents.

Since communicating my previous observations on this subject to the Royal Society (1),* I have received from the collector (R. Henry) to whom I owe most of my material, three embryos of *Apteryx australis*, which fill important gaps in the series of developmental stages formerly studied, and serve to correct one or two erroneous conclusions to which I was led by having, in so many cases, only a single specimen of each stage.

The youngest of the three embryos is as nearly as possible intermediate in age between Stages E and F of my former paper: I shall speak of it as Stage E′.

The second is slightly more advanced than Stage F, and will be called F′.

The third is considerably more advanced than Stage G, but far less advanced than H: it will be spoken of as G′.

Within the last few months, Baldwin Spencer has published a pamphlet (2) which should be of great use to any one working out the general embryology of a Bird. In describing the earlier stages of *Apteryx* I found great inconvenience (1, p. 28, *note*) in having no definite standard of reference. In the ordinary works on

* The numbers in brackets refer to the List of Works Referred to at the end of the paper (p. 81).

embryology there are no detailed descriptions of the external form of the Chick at the various stages of its development, and the particular day at which certain structures appear is subject to considerable individual variation. SPENCER has now done for the Chick, the most convenient type for Avian embryology, what BALFOUR did for the Elasmobranchs—described and figured a typical series of embryos, distinguishing each stage by a letter.

I think it will be useful if I indicate by a Table the stages in SPENCER's paper which correspond most nearly with those of *Apteryx* as described by me.

Stages of *Apteryx*.	Stages of Chick (SPENCER).
A	Between P and Q.
B	Slightly older than Q.
C	Between Q and R.
D	Slightly younger than S.
E, E′	Between S and T.
F	Slightly younger than T.
F′	Almost the same as T.
G	Somewhat older than T.
G′	Almost the same as U.
H	Almost the same as W.

I. EXTERNAL FORM.

Stage E′ (Plate 7, fig. 1).

This embryo closely resembles Stage F (1, Plate 3, fig. 8), but, as the proportions of the beak and the characters of the fore-limb approach more nearly to those of the damaged embryo which constituted Stage E (1, Plate 8, fig. 6), I have thought it advisable to figure it as a whole. The total length from tip of beak to end of tail is about 62 mm., *i.e.*, a little longer than Stage F, which belonged to the smaller species, *A. oweni*.

Although the beak is proportionally very little longer than that of Stage E, the characteristic form of the tip is attained.

The fore-limb is about intermediate in form between those of E and F; all three digits are well marked, but the second considerably exceeds the first and third, which are as nearly as possible of equal size. The hind-limb approaches more nearly to that of F, but the digits are shorter.

The first faint indication of the dorsal pteryla is visible.

Stage F′ (Plate 7, fig. 2).

The resemblance to Stage F (1, Plate 3, fig. 8) is very close, the chief differences

being the increased length of the beak and the greater distinctness of the feather-tracts. The total length, from tip of beak to end of tail, is 70 mm.

The fore-limb (fig. 2) differs from that of F (1, Plate 3, fig. 9), in the fact that the pollex is particularly well marked, having the form of a large, bluntly-pointed projection (1) on the pre-axial side of the manus. The fore-limb at this stage is a thoroughly typical wing, closely resembling that of an embryo carinate bird of SPENCER's Stage T.

Stage G′.

This is the most important of the additional stages, since it serves to fill up the very considerable gap between Stages G and H of my former paper.

The total length, from tip of beak to uropygium, is 130 mm.; the head is nearly as convex as in Stage G (1, Plate 3, fig. 10), but otherwise the form approaches more nearly to that of H.

The feathers on the dorsal pteryla, which now reaches well on to the top of the head, have attained a length of 7 mm., and are nearly black. Those on the femoral tract are a little shorter, and are beginning to turn black; the rest are still colourless, and those on the front and sides of the head are mere papillæ. The vibrissæ, or hair-like feathers at the base of the beak, are already distinguished from the others in the same region by their greater length. Reference to fig. 8 (Plate 3) of my former paper shows that these characteristic structures are distinctly visible in Stage F. The scales on the feet are marked out, but are still colourless and quite soft.

II. THE SKULL.

Stages E′ and F′ (Plate 8, figs. 9–11).

The head of the former of these stages (E′) was, after removal of the brain, cut into a complete series of horizontal sections, taken as nearly as possible parallel with the floor of the pituitary fossa. That of F′ was first dissected and then sectioned, also horizontally. The following are the most important additional points made out :—

The internal auditory meatus and the floccular fossa are continuous, forming an elongated vacuity in the mesial wall of the auditory capsule. The VIIth and VIIIth nerves pass through the dura mater, filling the anterior end of the vacuity, while the rest of it is simply plugged with a thickened mass of dura, there being at this stage no indication of the flocculus.

The structure of the dorsum sellæ and of the pituitary floor is well shown, several points becoming quite clear which could only be imperfectly ascertained either by dissection or by transverse and sagittal sections.

Sections taken through the ridge of the dorsum sellæ (fig. 9) show it to be a continuous transverse wall of cartilage. The median portion, however, shows special

characters; it (*Pr.Ch.*) is convex cephalad and concave caudad, and is separated from the lateral regions by lines of close-set cells. Passing ventrad (fig. 10) the cartilage disappears in the middle line, the central portion of the lower part of the dorsum sellæ being formed merely by the fibrous tissue of the posterior basi-cranial fontanelle. Thus the extreme dorso-median portion of the dorsum sellæ is formed by a transverse bridge of cartilage, not perfectly continuous with the cartilage of the parachordal regions on either side. This transverse bridge is the prochordal cartilage; in the present instance it is a less distinct structure than it appears to be in either sagittal or transverse sections (1, Plate 10, figs. 108, 112, 114), having evidently fused posteriorly with the lateral or parachordal regions of the dorsum sellæ.

In all previous sections the end of the notochord was found to be curved gently upwards, ending in the fibrous tissue of the dorsum sellæ, just below the prochordal cartilage (1, Plate 10, figs. 101 and 111; Plate 14, figs. 173 and 174). In the present instance it turns forward and slightly to the left (fig. 10, *Nch.*), projecting between the internal carotids in the fibrous tissue of the pituitary floor.

The three basi-cranial fontanelles are well shown in a single section (fig. 11) through the floor of the pituitary fossa. The posterior (*p.bcr.fo.*) is a wide space containing the notochord; the anterior (*a.bcr.fo.*) is filled with small, close-set cells, and contains the pituitary pedicle (*Pty.ped.*); the middle (*m.bcr.fo.*) is filled with small-celled tissue, and contains a narrow canal, in which neither cells nor coagulum can be seen. Traced ventrad, this canal simply merges into the perichondrium; traced dorsad, it breaks up into several canals containing small, deeply-stained cells, which appear to be leucocytes. The middle portions of the two commissures (x and y), separating the three fontanelles, are imperfectly chondrified, and a similar non-cartilaginous area (w) extends on each side across the cartilage, separating the posterior basi-cranial fontanelle from the carotid foramen.

Taking all these facts into consideration, it appears to me that my former explanation of the basi-cranial fontanelles (1, p. 61), is erroneous; that the line of junction between the trabeculæ and parachordals is represented by the area w, the longitudinal bands between the fontanelles indicating the plane of fusion of the trabeculæ with one another. Moreover, the cartilage immediately cephalad of w can be traced ventrad into the ridges (1, p. 64, Plate 11, fig. 126, r), which form the lateral boundaries of the posterior basi-cranial fontanelle, whence it would appear that the ridges in question represent the cornua trabeculæ. The resemblance to the early stages of the Crocodile's skull is thus very close (3, Plate 63, fig. 4).

Under these circumstances the only explanation I can offer of the middle basi-cranial fontanelle is that it is an inter-trabecular fissure, due to the imperfect fusion of the trabeculæ, and finally obliterated by their complete concrescence.

The structure of the presphenoid region is also well seen in these sections. It is formed (fig. 10) of perfectly distinct paired plates of cartilage, the dorsal portions of which (orbito-sphenoid, *Orb.Sph.*) are divergent, while their ventral portions (pre-

sphenoid, *Pr.Sph*), are parallel and separated from one another by dense fibrous tissue. At this stage, therefore, the presphenoid consists, as in Stage D (1, Plate 9, fig. 90) of paired laminæ, which pass insensibly in front into the unpaired mesethmoid.

A re-examination of the sections of Stage G seems to show that the median fibrous portion of the presphenoid is chondrified from below upwards, the chondrification extending above the ventral edges of the orbito-sphenoids so as to give the peculiar relations shown in 1, Plate 11, fig. 135. This may possibly indicate the presence of an inter-trabecula, although if such an element occurs at all it is certainly not a distinct chondrite in any of my stages. (Compare 3, Plate 64, fig. 2, with 1, Plate 9, fig. 90, and Plate 11, figs. 133 and 135).

Stage G′ (Plate 7, figs. 3–8).

The skull of this embryo was prepared by dissection; it serves to correct various imperfections in my description of Stage G, in which the material at hand was insufficient.

The chondrocranium has nearly attained its final form; the shape of the auditory capsules, alisphenoids, and ethmoidal region is practically the same as in Stages H–K; there is, however, no indication of the cartilage bones, so that the specimen is considerably less advanced than H.

The basi-temporals have not yet made their appearance, and the present stage is, therefore, valuable as showing the final form of the base of the skull before it has been modified by the underlying membrane bones. This is well seen by comparing figs. 4, 6, and 7 with Plate 9, figs. 76 and 77, and Plate 12, fig. 148, of my former paper.

The anterior tympanic recess (figs. 4 and 6, *a.tymp.r.*) is a deep pit floored only by membrane, and bounded in front by the basi-pterygoid process (*B.Ptg.Pr.*), the apparent length of which is much greater than in later stages. This is, of course, due to the fact that, on the appearance of the basi-temporal, its pretemporal wing extends laterad forming a floor to the anterior tympanic recess, and continuous in front with the basi-pterygoid process.

There is a large posterior basi-cranial fontanelle (*p.bcr.fo.*) filled with connective tissue and appearing as an actual aperture when the latter is removed. The anterior basi-cranial fontanelle (*a.bcr.fo.*), and the carotid canals passing inwards from the corresponding foramina (*Int.car.*) are clearly seen through the rostrum (*Rost.*) when the skull is examined by transmitted light. The middle fontanelle appears to have closed.

The presphenoidal region can be made out with great clearness. Posteriorly the presphenoid (fig. 3, *Pr.Sph.*) is separated from the orbito-sphenoid (*Orb.Sph.*) by narrow areas of connective tissue (x) as in Stage G (1, Plate 11, fig. 135); anteriorly they are continuous. The orbito-sphenoid (*Orb.Sph.*) is directed outwards and slightly

backwards forming the dorsal boundary of the optic foramen (figs. 3, 6, 7, and 8, *Nv. II.*), and having its outer edges overlapped by the alisphenoid. Against the mesial end of its anterior border abuts the orbitosphenoid process of the frontal (fig. 3 *Fr.* (*o.sph.pr.*)) which is already well formed; the remainder of the anterior border is connected with the inner face of the frontal by a strong sheet of fibrous tissue.

The membrane bones (figs. 3, 4, and 5) are considerably more advanced than in Stage G, but there is still no trace of parietals, and, as already remarked, the basitemporals have not appeared. The rostrum (fig. 8, *Rost.*), has sent off a short process from its posterior end which passes dorsad and applies itself to the cartilaginous basisphenoidal region.

III. The Sternum.

The only matter worthy of notice is that in Stage G′, there is a well-marked bifid posterior median process: in Stage G (1, Plate 16, fig. 218) this process had not made its appearance.

IV. The Shoulder-Girdle.

In my former paper the shoulder-girdle is shown as a solid mass of cartilage in Stages E-G, and in one specimen of H: in the other specimen of H the coracoid region is fenestrated, and presents a distinct procoracoid, while from Stage I onwards there is progressive degeneration of the procoracoid. Reference to the plates will show that all the specimens showing a solid coracoid region belong to *A. oweni* (1, Plate 17, figs. 233, 234, 235, and 237), while those in which a procoracoid is present are all either *A. australis* or *A. bulleri*.

The specimens upon which the present paper is founded are all examples of *A. australis*, and they bring to light the remarkable fact that there are striking specific differences in the development of the shoulder-girdle. Even in F′, which, as already remarked, is only slightly more advanced than F of the former paper, there is a distinct coracoid fenestra, and the procoracoid is not formed of hyaline cartilage. This point is still clearer in G′ (Plate 3, fig. 12), in which, except for the absence of ossification, the shoulder-girdle has the characters which my former observations indicated as being characteristic of the ripe embryo.

A re-examination of my sections of the embryo of *A. australis*, belonging to Stage G, shows the same thing: there is a distinct procoracoid, very narrow, and not formed of typical hyaline cartilage. I formerly overlooked this, my observations on this stage being founded mainly on the dissected specimen of *A. oweni*, in which a renewed examination shows no trace of a coracoid fenestra.

In E′ this coracoid is distinctly notched on its pre-axial border, the notch being filled with indifferent tissue, but I can detect no distinct procoracoid.

In this connection I may point out that in both the adult shoulder-girdles of *A. oweni* figured (1, Plate 16, figs 231 and 232), the coracoid has an even pre-axial border,

there being no trace of the coracoid fenestra beyond a thin area in the bone indicated by shading, whereas in the other species, except one specimen of *A. bulleri* (fig. 230), there is either a distinct coracoid fenestra or a notch representing it.

It would require an examination of numerous specimens of all species and of various ages to settle this point completely, but the data at our disposal certainly seem to point to the remarkable circumstance that in one species of *Apteryx* (*A. oweni*) the coracoid is solid, presenting no coracoid fenestra and therefore no procoracoid, while in another species (*A. australis*) the procoracoid is present at a comparatively early age, and is frequently retained in the form of a ligament, in the adult. In other words, the differences between the shoulder-girdle in two species of *Apteryx* are of precisely the same nature as those distinguishing the *Struthiones* from the other *Ratitæ*.

V. The Fore-Limb.

The specimens now under discussion serve to confirm the statements made in the previous paper (1, Plates 17 and 18) as to the extreme variability of the wing in *Apteryx*, and are further interesting as showing the occasional presence of an intermedium in the carpus—an element not hitherto observed in this genus, but shown to exist in *Dendroeca* by Morse (4) and in *Opisthocomus* by my Father (5).

In E′ (Plate 8, fig. 13) the proximal row of the carpus contains two chondrites, a rounded ulnare (*ul.*), and a large irregular element applied to the distal surface of the radius, and extending post-axiad into the space between the two bones of the fore-arm. In the left wing a longitudinal area of close-set cells divides it into a pre-axial portion (*ra.*), the radiale, and a post-axial moiety (*int.*), which may be taken to represent the intermedium. In the right wing this cartilage is undivided.

There are two distalia (*dist.* 2, *dist.* 3) apparently representing the second and third of the series, and both first and third metacarpals (*Mtcp.* 1, *Mtcp.* 3) are well developed.

In F′ (fig. 14) the number of carpals is the same. The radiale (*ra.*) has the trigonal form so common in later stages, the intermedium (*int.*) is small and imperfectly chondrified, and the ulnare (*ul.*) is large and rounded. There is a large second distale (*dist.* 2) applied to the proximal end of the second metacarpal (*Mtcp.* 2), and a very small and imperfectly chondrified third distale (*dist.* 3) closely applied to the ulnare.

In the right wing of the same specimen the carpals are very imperfectly differentiated and no chondrification has appeared in them.

In G′ (fig. 15) chondrification is complete. There is a large trigonal radiale (*ra.*), and post-axiad of it a small but distinct and well chondrified intermedium (*int.*); the radius articulates with both these chondrites. The ulna is in contact post-axiad with the ulnare (*ul.*) and pre-axiad with a large distale (*dist.*), which is

irregularly four-sided in longitudinal sections, and articulates with the radiale, intermedium, ulna, ulnare, and first and second metacarpals.

The first metacarpal (*Mtcp.* 1) is a short, cylindrical cartilage articulating with the radiale, distale, and second metacarpal, and standing out at right angles to the latter. The third metacarpal (*Mtcp.* 3) is about two-thirds the length of the second, to which it is applied along almost its whole length; proximally it articulates with the ulnare.

VI. The Brain.

The brain of Stage G (1, Plate 19, 308 and 309) was shown to want only an increase in size and forward extension of the cerebellum to convert it into a typical bird's brain.

These changes are precisely what have taken place in G′, the brain of which (figs. 16–19) is at what may be called the critical stage. The optic lobes are proportionally as large as ever, and have not begun to take on the ventral position, which, as the former paper showed, is fully attained in Stage H (1, Plate 19, fig. 310). The cerebellum has grown forward so as almost to meet the cerebral hemispheres, the characteristic sulci have made their appearance, and the flocculus (*floc.*) has attained its maximum size. Figs. 16–18 might very well pass for representations of the brain of a bird belonging to any of the lower carinate orders. The figures, moreover, are from dissections, and are therefore more reliable than figs. 308 and 309 of my former paper, which are reconstructed from sections.

A sagittal section (fig. 19) shows that the backward tilting of the diencephal, which is one of the most characteristic features of the adult brain (1, p. 106, Plate 19, fig. 301) has not yet taken place; the foramen of Monro (*for.M.*) and the various commissures are in their normal positions. The anterior moieties of the hemispheres are still strongly flexed ventrad, as in earlier stages.

VII. Summary.

1. In Stage E′ the characteristic form of the beak has already appeared (fig. 1); in Stage F′ the pollex is unusually large (fig. 2), giving the fore-limb the characters of the wing of a typical bird.

2. Horizontal sections of the head in Stage E′ show more satisfactorily than any of my former preparations the structure of the dorsum sellæ (figs. 9 and 10), the relations of the three basi-cranial fontanelles and of the trabecular and parachordal regions of the skull (fig. 11), and the structure of the presphenoid (fig. 10); the same specimen exhibits an unusual mode of termination of the notochord (fig. 10).

3. The skull in Stage G′ shows the final form of the chondrocranium before the

appearance of cartilage bones (figs. 3–8); it also shows more clearly than any of the material for my former paper, the relations of the pre- and orbito-sphenoidal regions.

4. A comparison of the present specimens with those formerly examined seems to show that in *A. oweni* there is always a solid coracoid region to the shoulder-girdle, while in *A. australis*, as far back as Stage F′ (perhaps even in E′) there is a coracoid fenestra and a ligamentous procoracoid (fig. 12).

5. In addition to the elements hitherto described in the carpus an intermedium may be present (fig. 13–15).

6. The brain in Stage G′, prepared by dissection, shows typical avian characters, the optic lobes having attained their maximum relative size, and the cerebellum having extended forwards to meet the cerebrum (figs. 16–19.)

List of Works Referred to.

1. Parker, T. J. "Observations on the Anatomy and Development of *Apteryx*." 'Phil. Trans.,' vol. 182 (B), 1891, p. 25.
2. Spencer, W. B. "The Nomenclature of Chicken Embryos for Teaching Purposes." 'Proc. Roy. Soc. Victoria,' 1890, p. 23.
3. Parker, W. K. "On the Structure and Development of the Skull in the Crocodilia." 'Trans. Zool. Soc.,' vol. 11, p. 263.
4. Morse. 'Annals Lyceum Nat. Hist. New York,' 1874, p. 146. (Quoted by W. K. Parker, 'Phil. Trans.,' vol. 179 (B), p. 386.)
5. Parker, W. K. "On the Morphology of a Reptilian Bird, *Opisthocomus cristatus*." 'Trans. Zool. Soc.,' vol. 13, part 2, p. 43.

Description of Plates 7 and 8.

Hyaline cartilage is coloured *green.*

PLATE 7.

Fig. 1. Stage E′. Entire embryo from the left side. *Na.ap.*, the nasal aperture.

Fig. 2. Stage F′. Left wing, showing unusually large pollex (1), elongated index (2), and small medius (3).

Figs. 3–8. Stage G. Views of the Skull.

References.

A.A.Trb., anterior accessory turbinal.
a.bcr.fo., anterior basi-cranial fontanelle.

Al.Sph., ali-sphenoid.
A.tymp.r., anterior tympanic recess.
B.Ptg.Pr., basi-pterygoid process.
Cb.V., foramen for cerebral vein.
Coch., cochlea.
flc.f., floccular fossa.
f.ov., fenestra ovalis.
Fr., frontal.
Fr. (*na.pr.*), nasal process of frontal.
Fr. (*o.sph.pr.*), orbito-sphenoid process of frontal.
Int.Car., carotid foramen.
Lac., lacrymal.
M.Eth., mesethmoid.
Mx., maxilla.
Na., nasal.
Na.ap., nasal aperture.
Nv.II., optic foramen.
Nv. V^1., orbito-nasal foramen.
Nv. $V^{2 \cdot 3}$., trigeminal foramen.
Oc.Cn., occipital condyle.
Orb.sph., orbito-sphenoid.
Pa.oc.pr., paroccipital process.
p.bcr.fo., posterior basi-cranial fontanelle.
Pmx., premaxilla.
pn.c., pneumatic cavity.
Pr.Na., prenasal cartilage.
Pr.Sph., presphenoid.
Ptg., pterygoid.
Qu., quadrate.
qu.^{1},*qu.*^{2}, facets for head of quadrate.
Rost., parasphenoidal rostrum.
S.orb.f., superior orbital fontanelle.
Sq., squamosal.
tg.pr., tegminal process.
Vo., vomer.
x., area of fibrous tissue separating posterior moiety of pre-sphenoid from orbito-sphenoid.

Fig. 3. Dorsal aspect, membranous roof and right frontal removed.
Fig. 4. Ventral aspect: the anterior basi-cranial fontanelle and the carotid canals are supposed to be seen through the transparent overlying parts.

Fig. 5. From left side.
Fig. 6. Ventral aspect: part only, after removal of membrane bones.
Fig. 7. From left side, after removal of membrane bones.
Fig. 8. Sagittal section.

PLATE 8.

Figs. 9–11. Stage E. Three horizontal sections of the head.

References.

a.bcr.fo., anterior basi-cranial fontanelle.
B.Art., basilar artery.
Dors.sell., dorsum sellæ.
Int.car., internal carotid artery.
m.bcr.fo., middle basi-cranial fontanelle.
Nch., notochord.
Nv.II., optic nerve.
Nv.V., trigeminal nerve.
Orb.Sph., orbito-sphenoid.
p.bcr.fo., posterior basi-cranial fontanelle.
Pr.Ch., prochordal cartilage.
Pr.Sph., presphenoid.
Pty.ped., pedicle of pituitary body.
Scl., sclerotic.
w., junction between trabecular and parachordal regions.
x., transverse commissure, separating anterior and middle basi-cranial fontanelles.
y., transverse commissure, separating middle and posterior basi-cranial fontanelles.

Fig. 9. Through ridge of dorsum sellæ, showing the partly concresced prochordal cartilage.
Fig. 10. Through ventral region of dorsum sellæ, about 0·4 mm. ventrad of fig. 9, showing the paired presphenoid plates and the dorsum sellæ, divided in the middle by the upward extension of the fibrous tissue of the posterior basi-cranial fontanelle.
Fig. 11. Through floor of pituitary fossa, about 0·5 mm. ventrad of fig. 10, showing the three basi-cranial fontanelles, and the line of junction between the trabecular and parachordal regions.

Fig. 12. Stage G′. Left shoulder-girdle.

acr.cor., acro-coracoid process.
Cor., coracoid.
gl., glenoid cavity.
Pr.Cor., procoracoid.
Scap., scapula.

Fig. 13. Stage E′ }
Fig. 14. Stage F′ } Longitudinal sections of fore-limb.
Fig. 15. Stage G′ }

References.

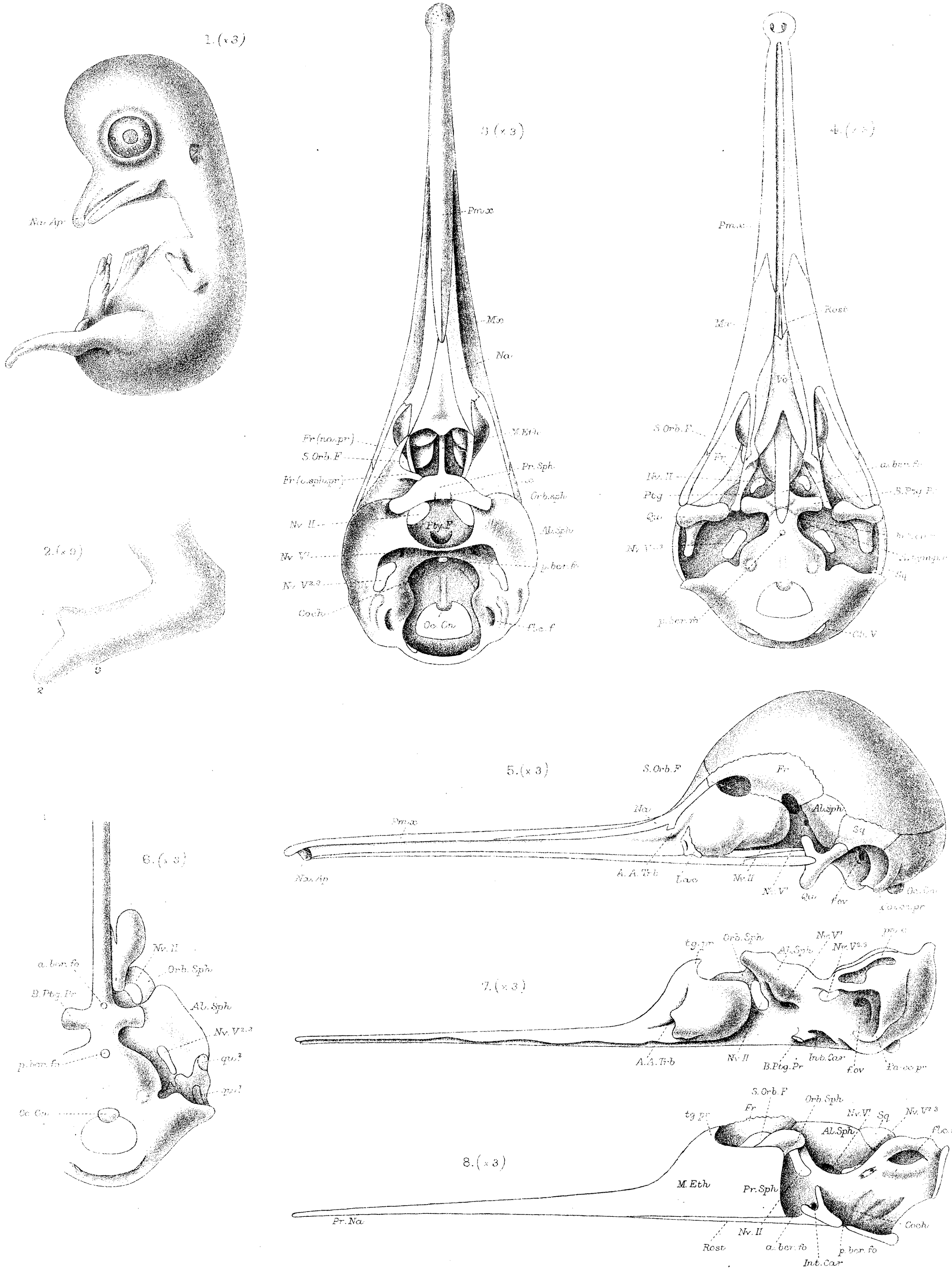
dist. 2, *dist.* 3, second and third distalia.
Hu., humerus.
int., intermedium.
Mtcp. 1, 2, *and* 3, first, second, and third metacarpals.
Ra., radius.
ra., radiale.
Ul., ulna.
ul., ulnare.

Figs. 16–19. Stage G′. The brain, from dissections.

References.

floc., flocculus.
For.M., foramen of Monro.
inf., infundibulum.
Nv.II., optic nerve.
opt.chs., optic chiasma.
opt.thal., optic thalamus.
Pin., pineal body.
vel.int., velum interpositum.

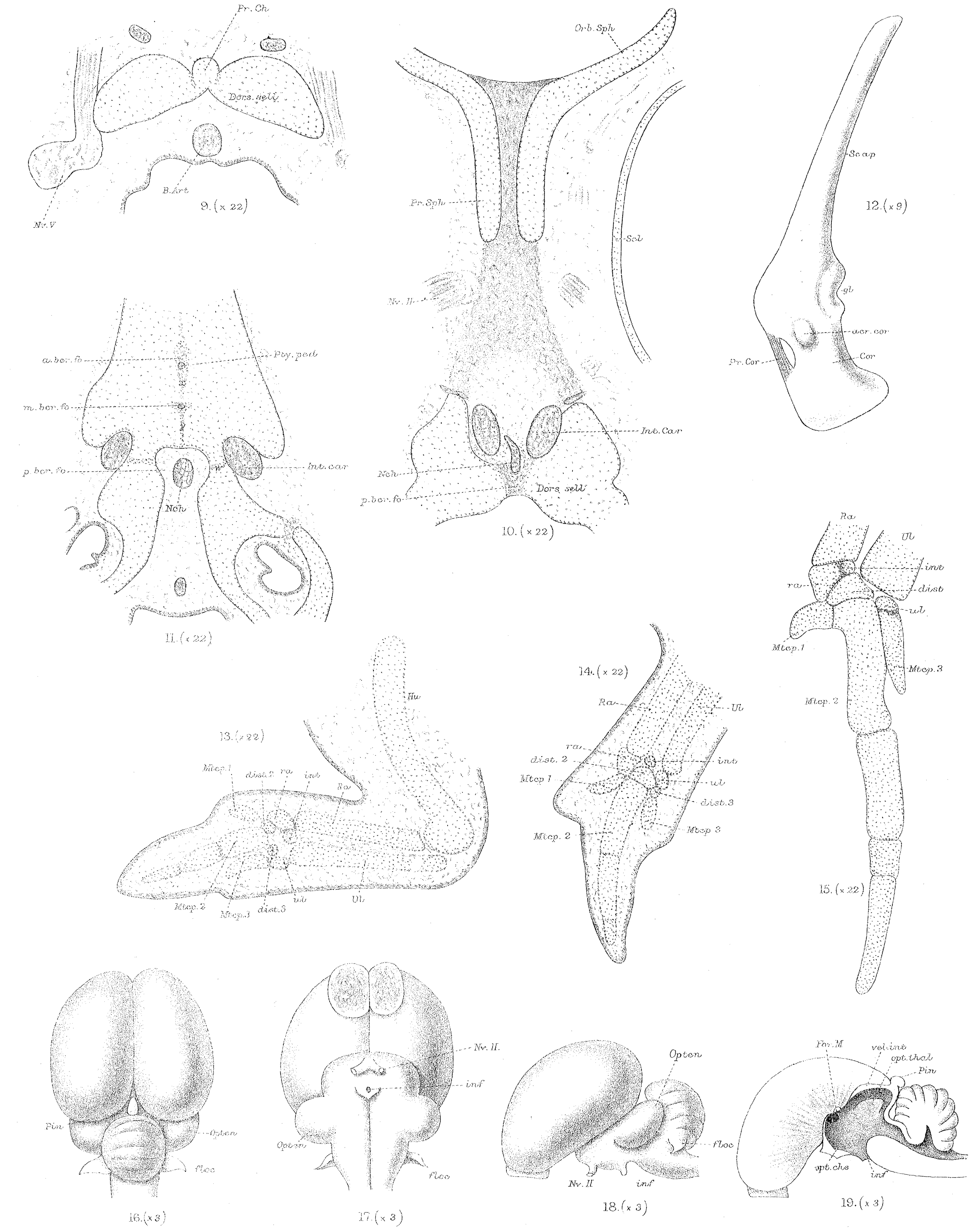
Fig. 16. From above.
Fig. 17. From below.
Fig. 18. From left side.
Fig. 19. Sagittal section.



T.J.P. ad nat. del.
M.P. Parker chr. lith.

West, Newman imp.

APTERYX AUSTRALIS.



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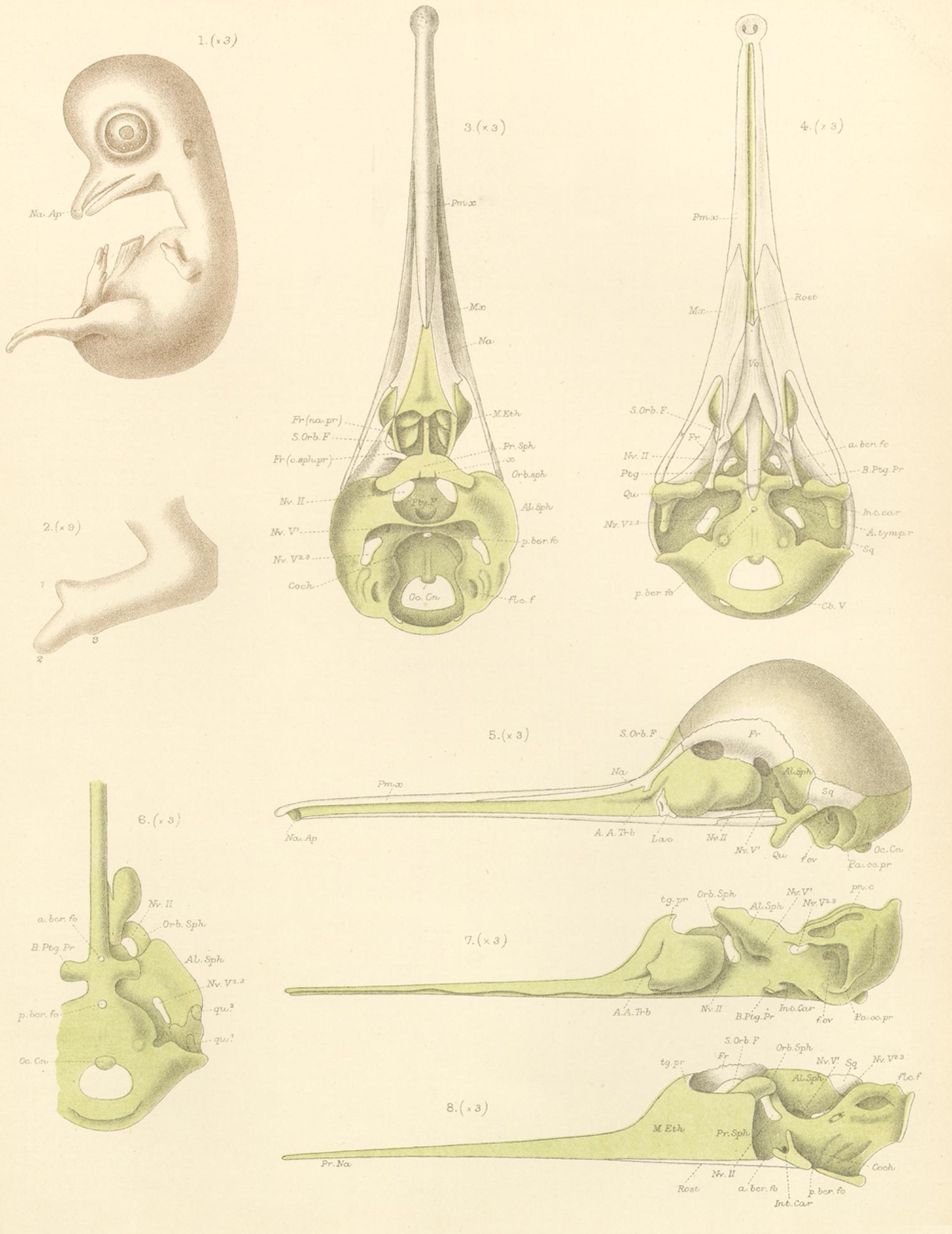

APTERYX AUSTRALIS.

PLATE 7.

Fig. 1. Stage E′. Entire embryo from the left side. *Na.ap.*, the nasal aperture.

Fig. 2. Stage F′. Left wing, showing unusually large pollex (1), elongated index (2), and small medius (3).

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Oc.Cn., occipital condyle.
Orb.sph., orbito-sphenoid.
Pa.oc.pr., paroccipital process.
p.bcr.fo., posterior basi-cranial fontanelle.
Pmx., premaxilla.
pn.c., pneumatic cavity.
Pr.Na., prenasal cartilage.
Pr.Sph., presphenoid.
Ptg., pterygoid.
Qu., quadrate.
$qu.^1, qu.^2$, facets for head of quadrate.
Rost., parasphenoidal rostrum.
S.orb.f., superior orbital fontanelle.
Sq., squamosal.
tg.pr., tegminal process.
Vo., vomer.
x., area of fibrous tissue separating posterior moiety of pre sphenoid from orbito-sphenoid.

Fig. 3. Dorsal aspect, membranous roof and right frontal removed.

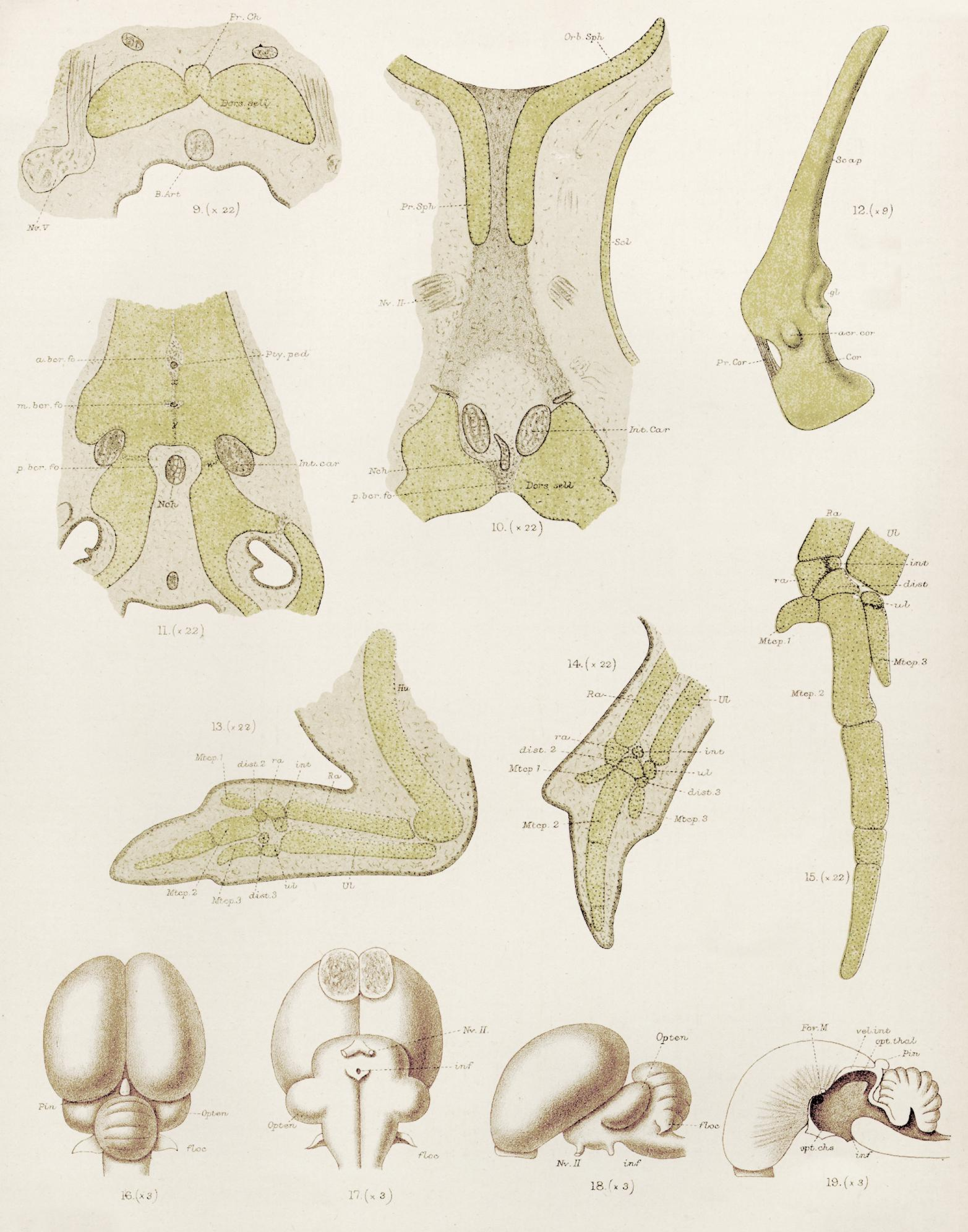
Fig. 4. Ventral aspect: the anterior basi-cranial fontanelle and the carotid canals are supposed to be seen through the transparent overlying parts.

Fig. 5. From left side.

Fig. 6. Ventral aspect: part only, after removal of membrane bones.

Fig. 7. From left side, after removal of membrane bones.

Fig. 8. Sagittal section.



APTERYX AUSTRALIS.

PLATE 8.

Figs. 9–11. Stage E. Three horizontal sections of the head.

References.

a.bcr.fo., anterior basi-cranial fontanelle.
B.Art., basilar artery.
Dors.sell., dorsum sellæ.
Int.car., internal carotid artery.
m.bcr.fo., middle basi-cranial fontanelle.
Nch., notochord.
Nv.II., optic nerve.
Nv.V., trigeminal nerve.
Orb.Sph., orbito-sphenoid.
p.bcr.fo., posterior basi-cranial fontanelle.
Pr.Ch., prochordal cartilage.
Pr.Sph., presphenoid.
Pty.ped., pedicle of pituitary body.
Scl., sclerotic.
w., junction between trabecular and parachordal regions.
x., transverse commissure, separating anterior and middle basi-cranial fontanelles.
y., transverse commissure, separating middle and posterior basi-cranial fontanelles.

Fig. 9. Through ridge of dorsum sellæ, showing the partly concresced prochordal cartilage.
Fig. 10. Through ventral region of dorsum sellæ, about 0·4 mm. ventrad of fig. 9, showing the paired presphenoid plates and the dorsum sellæ, divided in the middle by the upward extension of the fibrous tissue of the posterior basi-cranial fontanelle.
Fig. 11. Through floor of pituitary fossa, about 0·5 mm. ventrad of fig. 10, showing the three basi-cranial fontanelles, and the line of junction between the trabecular and parachordal regions.
Fig. 12. Stage G′. Left shoulder-girdle.

acr.cor., acro-coracoid process.
Cor., coracoid.
gl., glenoid cavity.
Pr.Cor., procoracoid.
Scap., scapula.

Fig. 13. Stage E′ } Longitudinal sections of fore-limb.
Fig. 14. Stage F′ }
Fig. 15. Stage G′ }

References.

dist. 2, *dist.* 3, second and third distalia.
Hu., humerus.
int., intermedium.
Mtcp. 1, 2, *and* 3, first, second, and third metacarpals.
Ra., radius.
ra., radiale.
Ul., ulna.
ul., ulnare.

Figs. 16–19. Stage G′. The brain, from dissections.

References.

floc., flocculus.
For.M., foramen of MONRO.
inf., infundibulum.
Nv.II., optic nerve.
opt.chs., optic chiasma.
opt.thal., optic thalamus.
Pin., pineal body.
vel.int., velum interpositum.

Fig. 16. From above.
Fig. 17. From below.
Fig. 18. From left side.
Fig. 19. Sagittal section.