XV. The Croonian Lecture.—*On the Structure and Development of the Skull in the Lacertilia.*

Part I.—*On the Skull of the Common Lizards* (Lacerta agilis, L. viridis, *and* Zootoca vivipara).

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[Plates 37–45.]

Whilst the last paper, that on the Skull of the Snake, has been passing through the press, I have been engaged in working out the skull of the Common Lizards; hence the likeness and unlikeness of the two kinds has been clearly before my eyes.

I consider these small, *modern, old-world* "Lacertilia" to be the kinds in which the Lacertian specialization has been carried to its fullest development, and that an exhaustive account of their cranio-facial skeleton, its structure and its growth, may serve as a sort of practical rule or *norma* by which to measure that which is typical, or aberrant, in the skull of other types of the Lacertilia.

Besides this piece of work on my selected pattern form, I have to offer to the Royal Society a lesser paper on the skull of one of the lowest and most aberrant of the "Families," namely, the "Chamæleonidæ."

This I have worked out in the ripe embryo and adult of the common species, and in the adult of the Dwarf Chamæleon—one of the outliers of the Family.

But in *Lacerta* I am able to give *seven* stages of the unborn embryo, besides the adult; and six of these stages I owe to the kindness of Dr. Max Braun, of Würzburg; the specimens of *Zootoca vivipara* I owe to Professor Rupert Jones, F.R.S.; and the Green Lizard to Professor Alfred Garrod, F.R.S.

The accumulation, during many years, of "old experience," and the slow training I have had in delicacy of touch and sharpness of sight, have only barely served me in the present piece of work; even the adult skull, in so small a kind, has to be worked out with the greatest pains and patience, and asks for several weeks of continued labour.

In the embryos, however, I have had to handle the smallest and softest little Vertebrate "Worms:" these I have split, carved, and sliced, so as to reveal many embryological facts of great importance, and by these I have been enabled to follow

and to overlap the work of my talented and esteemed friend, Mr. F. M. BALFOUR, of Cambridge.

As my work is only a branch growing out of "General Embryology," I am not responsible for more proper embryological work than is sufficient for me, so that I may be able to graft my work on to the grand stock below.

To no fellow-worker am I more indebted than to him whose name I have just mentioned, but I am deeply indebted to others also.

The works and papers that have bestead me the most this time are the following, namely :—

Professor HUXLEY'S 'Elements,' pp. 219–244 (1864), and his 'Manual of the Anatomy of the Vertebrated Animals,' pp. 193–271 (1871).

FOSTER and BALFOUR'S 'Elements of Embryology,' Part I. (MACMILLAN and Co., 1874.)

Mr. F. M. BALFOUR'S Monograph 'On the Development of the Elasmobranch Fishes,' 8vo. (MACMILLAN and Co., 1878.)

Dr. A. MILNES MARSHALL, "On the Development of the Cranial Nerves in the Chick" ('Quarterly Journal of Microscopical Science,' vol. xviii., New Series, plates 2 and 3, pp. 1–31.)

In referring to my own papers, I may remark that the last, namely, that on the "Snake's Skull" (Phil. Trans. 1878, Part II., Plates 27–33, pp. 385–417), is most vital to the present piece of enquiry.

Yet that paper, by itself, would have been a very poor guide to me in this ; I have been glad to fetch my knowledge from afar—from Amphibia and Fishes below, and from Birds and Mammals above, the special "subject" in hand.

A cursory view of my figure of the upper surface of the Lizard's skull might beguile the observer into supposing that it belonged to a Ganoid Fish, or at any rate to a *Labyrinthodon*, for the outer cranial elements are but little modified from what is seen in those types.

But if we dig through the outer crust of the skull we shall find specializations of the most remarkable kind, some of which culminate in the typical Lizard, whilst others are anticipations, in an arrested form, of what carries the skull to so high a metamorphic pitch in the Bird.

No greater error, however, could be made than to suppose such a form as the *Nimble Lizard parental* to any kind of Bird ; it is a culminating type itself, although not running up to so great a height as its feathered relations.

Yet we see in this Lizard notable beginnings of metamorphic modifications of the cranial elements that are positively meaningless in the creature itself, and the use of which is only to be seen where metamorphosis has had full swing in the skull of a high-class Bird.

Moreover, some things, such as the articulation of the pterygoid bones with the skull, take place with the same fine detail of delicate metamorphosis in this Lizard as

in the *middle-class* Bird (Fowl, Goose, &c.), whereas the *low* Bird (the Ostrich and its relatives) does not show so high a condition, and the highest Birds (Crows, Songsters, and Parrots) abort these very parts, going beyond that degree of specialization.

This corresponds with what I showed twelve years ago, namely, that the Struthious type of skull contained several *Batrachian* (sub-reptilian) characters: in height, zoologically, the high Lizard is in some respects on a level with the Fowl and the Goose—birds of the middle level.

The skull of this normal Lizard has so many points of zoological and of morphological interest, that I shall, as I did in my paper on the "Salmon's Skull," describe the adult condition first, and then go back to its primordial state, and trace it step by step upwards.

The skull of the adult Lizard is a very compound piece of architecture, whether we consider the "stones" of the building or its "style;" it is a sort of accretion of all that has gone before it in the Vertebrate sub-kingdom.

Hence, if I fail in giving a simple morphological solution of all its structural difficulties, I shall fail for want of knowledge of the structure and development of the Vertebrata that lie below the Lizards of this epoch, and of the Reptiles (generally) of this epoch.

As to the members of the great Reptilian class, extinct and recent, of the latter much remains to be done, but they are within reach; of the extinct forms, most of the shreds and patches of our knowledge of them relate to the dermo-skeleton merely.

But the true opener of the eyes is the study of *development*, and the light lit by this method goes on increasing in its illuminating power, as type after type is set in light.

Skull of Adult Lizards. (Lacerta *and* Zootoca.)

a. The investing bones. The epidermic scales and their matrix are both very thin; only in the head and across the coracoids do dermal bones exist in *Lacerta*; in some kinds, as *Cyclodus* and *Anguis*, the *scales* of the body have "scutes" of bone beneath them.

The cephalic "scutes" of *Lacerta* are ossifications of the inner part of the "cutis vera" and of the subcutaneous stroma; they are composed of both these layers, and are scabrous where no muscle intervenes, but their sub-muscular tracts are smooth, and are subcutaneous in origin.

Thus the *ganoid layer* is gone, and yet most of the splints of the head are true "dermostoses" or dermal scutes, and their proper counterparts may be traced downwards through the lower forms of Reptiles, Amphibia ("Labyrinthodonts"), and Ganoid Fishes.

Some Lizards, as the "Varanians" or *Monitors*, have their investing bones as much specialized as the Osseous Fishes on one hand, and the Birds on the other: *Lacerta* has a very generalized bony roof to its skull.

For comparison with it we may conveniently take the existing Ganoids (*Acipenser*, *Polypterus*, *Lepidosteus*, &c.), and also the very instructive skulls of the "Siluroid" *Teleosteans*—such as *Callichthys*, *Doras*, and *Clarias*.

Even at this height, in the culminating Lacertian, the stone does not quite cover the well's mouth—the old familiar "fontanelle" is to be seen at the middle of the ankylosed *sagittal* line (Plate 42, fig. 1, *fo.*); in *Clarias capensis* it is further back, and there is another longer chink between the frontals; in the Chamæleon the single hole is *frontal*.

The fused parietals (*p.*) make a large square roof-shingle; the outer edge joins the largest supra-temporal (*s.t*[1].) by a toothed suture; the coronal suture also is toothed, and almost straight across; the occipital edge is shelving, and each hind angle sends down a crescentic "horn."

The parietal plate so rests upon the narrow ascending superoccipital (fig. 4, *p.*, *s.o.*) as to leave between it and each "horn" an oval supra-temporal space; a covered shed for the temporal muscle.

Each horn rests, by an enlarged trilobate root, upon the extended auditory masses (parotics); the horns are subcutaneous and smooth; the rough top of the bone is marked by the overlying scales, which in both parietals and supra-temporals, are in non-conformity with the cranial sutures (Plate 42, fig. 1).

The frontals (Plate 42, fig. 1, *f.*) are longer, narrower, and more irregular than the parietals; they have retained the frontal suture; in the hinder third of which there is a fossa, the scarcely-closed anterior "fontanelle" of *Clarias*.

The frontals are broadest at the coronal suture; they then narrow and widen again twice, and are narrowest in front at the transverse nasal suture.

But for the curious *atavistic* multiplication of scutes, the frontals of *Lacerta* would have been very large, yet, as in many archaic Vertebrata, the *super-orbital* region has its own bony eave, composed of two rows of tiles (figs. 1, 3, *s.ob.*).

Of these the inner row is composed of four, the hinder piece small, the foremost smaller, and the two others large ovato-acuminate scutes.

Outside these, a second row of five smaller oblong scutes finishes the overhanging "brow;" four of these are *super*-orbital, and the last is turned downwards as a *post*-orbital bone.

But the most constant "post-orbital" ("post-frontal," CUV.) is as large as the corresponding parietal moiety along which it is placed; it is a large convex sub-oval scute, reaching from the orbit to the occiput (Plate 4, figs. 1–5, *pt.o.*).

Outside the hinder part of this bone is another less than half its size (*s.t.*[1]); it is an irregularly oval scute with its pointed end forwards; above, it overlaps the great post-orbital, and below, the ascending, pointed part of the squamosal (*sq.*).

This latter bone is a sickle, whose pointed end runs forward below the edge of the hinder half of the post-orbital, and within the first supra-temporal; its thick end is turned downwards, and is articulated to the head (or "otic process") of the quadrate (*sq.*, *q.*); that joint has a synovial cavity lined with cartilage.

A sharp bony wedge, the second supra-temporal (*s.t.*^{2}) is jammed in between the squamosal and the parietal horn behind (fig. 4), its thick end rests upon the "parotic process" (*op.*), its sharp top runs inwards as well as upwards.

In many kinds (*Monitor, Iguana, Læmanctus, Cyclodus,* &c.), the *first* supra-temporal is wanting, the *second* is constant, and even exists in the Snakes, whilst they are young ("Snake's Skull," Plate 31, fig. 7).

These four bones—the post-orbital, squamosal, and first and second *supra*-temporals—are the *temporal* counterparts of the double row of super-orbitals; the squamosal and first supra-temporal are the outer row, and the others form the inner; properly speaking these are all supra-temporals.

The first and last of the *sub-orbital* series of the bony fish re-appear in this Lizard; the fifth or down-turned super-orbital (or outer post-orbital) scute is the same as the suspensory piece of the chain, behind; the front attaching bone is here the small perforated lachrymal (*l.*).

This bone is very constant in the "Lacertilia," but is always small. It lies on the maxillary, and is touched by the point of the jugal (*mx., j.*); these bones and the two foremost super-orbitals overlap the Cuvierian "prefrontal," a conchoidal *deep* scute (figs. 1 and 3, *p.f.*).

This bone keeps free on the surface of the nasal wall, as it does in the "Urodeles;" in them I have called it ecto-ethmoid: either name fits it.

In Ganoid and Osseous Fishes, and in Birds, this bone is represented by a *deeper* layer: an "ectostosis," which ossifies the ecto-ethmoidal or prefrontal mass.

Where the skull closes in behind the nasal sacs, there should be a median bone, a "meso-ethmoidal;" it exists as a parostosis in *Iguana tuberculata*, as in some Fishes (*e.g., Salmo*); in *Clarias* it is dermosteal, but in the Cyprinoids, and generally, in the "Anacanthini," and "Acanthopteri," it is an ectosteal plate ossifying the meso-ethmoidal cartilage.

So it is in the Ostrich and his relations, but in other Birds it has no separate beginning ("Ostrich's Skull," Plate 8).

In Birds the nasal processes of the pre-maxillaries keep the nasals apart; in this Lizard, and even in the Iguana, where there are two azygous plates, the nasals meet.

They are supero-lateral bones, notwithstanding, as all the Holostean Ganoids, and Teleosteans, show; the Amphibia also teach this.

Here in *Lacerta* the nasals meet in their hinder half (Plate 42, fig. 1, *n.*); they are separated from the prefrontals by a spike of the maxillary on each side, and from each other in front by the nasal process of the single premaxillary.

With that process they form a sort of pentagon; they make a straight suture across, with the frontals, and overlap the alinasal cartilage, antero-externally.

Inside the alinasal cartilage, flooring the nostril, another scale is found, the septo-maxillary (Plate 43, fig. 1, *s.mx.*); this little conchoidal *sub-mucous* scute lies upon the nasal gland (*n.g.*), and flanks the septum nasi (*s.n.*).

This is the *sub*-orbital "os terminale," whilst the nasal is "the *super*-orbital "os terminale;" they were, in the Fish-class, the two end bones of the lateral-line "fork;" over the eye and under the eye; the "supra-temporals" joined these to the "post-temporals,' or foremost lateral-line bones of the trunk. (See "Shoulder-girdle and Sternum," Plates 1 and 2, pp. 10–57.)

The upper jaws and cheek bones belong to a lower category of scutes arising, *in the body,* below the bones of the lateral-line; they are the highest of the infero-lateral series; the splints of the lower jaw belong to the sub-mesial ventral series.

When the axis is developed largely in front of the mouth, there then may be (as in *Acipenser*, but much more in *Polyodon*) a long series of ventral and sub-ventral bones under the "rostrum."

These, as Mr. BRIDGE'S valuable paper shows, are constantly showing (as in the dorsal region of the head) an alternation of azygous with paired scutes or plates.

In the Lizard even, and still better in birds with a double vomer, this is seen; in the latter we have two vomers, then one parasphenoid, and two basi-temporals: just a miniature of what is seen under the "rostrum" of *Polyodon.* Truly, a marvellous instance of atavism!

The præmaxillary (*px.*) forms a key-stone to the arch of the upper jaw; it is rather small, rounded in front, dentigerous, has a flat acuminate nasal process, and a seed-shaped palatine process. Here it is single; in some Lizards, as *Cyclodus*, there are two.

The maxillaries are developed almost as much as in some of the lower Mammalia, and far more than in most birds where the præmaxillaries are prepotent.

Each large toothed bone (*mx.*) well walls in the fore face; it runs up high, touches the frontal, and wedges in between the nasal and prefrontal.

Below, inside the wide alveolar region, there is a distinct palatal selvedge, which binds under the vomer and palatine (fig. 2, *v.*, *pa.*).

The outer nostril with its valve of cartilage is neatly walled round by the præmaxillary, maxillary, and nasal (figs. 1, 3, *px.*, *mx.*, *n.*, *e.n.*, *ol.*).

The orbit is finished below by the cheek bone or jugal (*j.*); this is set obliquely on to the jugal process of the maxillary, along which it runs, as a fine style, up to the small, perforate, sunken lachrymal (*l.*).

Behind, it sends backwards a free snag, and then gradually narrows upwards, and is attached to the lesser and greater post-orbitals (fig. 3). There the cheek series ends, so that we miss the quadrato-jugal, which is only present in the Lacertilia in *Hatteria,* although constant in Tortoises and Crocodiles.

In this region, as in many others, the Bird bears hereditary marks of some very generalized fore-parents, whose dermal armature was composed of many plates.

In not a few birds—Emu, Barn Owl, Heron, Cormorant, &c.—there is a "post-maxillary," besides the quadrato-jugal and jugal, making *four* bones in the jugo-maxillary chain, and reminding the morphologist of *Lepidosteus.*

In the Batrachia, where the cheek is bound on to the suspensorium for the *first* time,

there is no distinction between the quadrato-jugal and the jugal; this also occurs where that specialization is seen for the *last* time, namely, in the huge "Family" or "Order" of the *Aves Ægithognathæ.*

In the lower face we miss the "jugulars" (the slabs under the floor of the mouth in Ganoid Fishes); they are sub-mesial scutes, without an odd one; here we get two bones that belong to the next row above them, and two more that show themselves at that line.

For on the mandibular axis (articulo-Meckelian rod) the coronoid and splenial (Plate 43, fig 2, *cr.*, *sp.*) are equivalent to ingrowing scutes next outside the "jugulars;" the "angulare" and "surangulare" also (*ag.*, *s.ag.*,) appear on the inner face of the mandible.

The dentary (*d.*) is the serial homologue of the maxillary and of the præmaxillary; not much of this large splint can be seen from its inner side (Plate 43, fig. 3), except its alveolar wall.

The coronoid (*cr.*) is very high, the splenial (*sp.*) long, large, and falcate; the angulare (*ag.*) is a trough, and the surangulare (*s.ag.*) a thick wall-plate to the hinder third of the mandibular axis.

The ventral region of the fore-face has a pair of bones in front and an odd one behind; this pair are the vomers, and the odd bone the parasphenoid (Plate 42, fig. 2, *v.*, *pa.s.*).

The vomers are large lanceolate splints, hollow above, and swelling, below; they are wedged in between the front half of the palatine portion of the maxillaries.

These bones, with the septo-maxillaries, are to be seen again and again in their relation to the nasal labyrinth and nasal glands, in the sections of those parts (Plate 44).

The cranio-facial axis (*p.e.*, *s.n.*) rests on the harmony-suture formed by the right and left vomers; their outer edge, behind, is the inner boundary of the inner nostrils (*i.n.*).

The parasphenoid (Plate 42, fig. 2, and Plate 43, fig. 1, *pa.s.*) is a very small, sharp style, hollow above, convex below, and ankylosed, behind, to the basisphenoid (*b.s.*); it only reaches half way to the vomer, exposing the base of the septum orbitarum.

These are all the true *dermal bones* I can find in *Lacerta*; but in the palate there are three pairs of bones formed in "indifferent tissue"—practically parosteal, but representing ectosteal plates in many of the *Ichthyopsida.*

The foremost pair, the palatines (Plate 42, fig. 2, *pa.*) belong to the palatine arch, and so do the outer bones or transpalatines (*t.pa.*); but the hinder pair, the pterygoids (*pg.*), belong to the *symplectic* outgrowths of the suspensorium of the mandible (quadrate).

Where the "pith" of the palatine arch ("ethmo-palatine" cartilage) is well developed, as in Ganoid and Teleostean Fishes, there the bony deposit on it is a deep or ectosteal lamina.

But as we ascend, there is less and less cartilage developed in the "second pre-oral

arch"; even in the Axolotl (Phil. Trans., 1877, Plate 24, figs. 1–3) there is only a small proximal, and a small distal, cartilage (the "ethmo-palatine" and "post-palatine" cartilages), whilst the *symplectic* outgrowth of the suspensorium is very large.

Here, in *Lacerta* (as in most Sharks), in other Lacertilia, and Birds, there is only a small ethmo-palatine cartilage, early confluent with the antorbital portion of the nasal capsule; it is a mere rudiment.

Thus we get the correlated bony deposits developing almost irrelatively to the stunted axis of this arch; yet even they are ossifications of tracts of tissue that only needed *time* to have been formed into true hyaline cartilages.

Therefore it is evident that these membrane bones are not to be confounded with such as are mere ossifications of a subcutaneous "stroma," homologous with the inner layer of a Ganoid scute.

The palatines (Plate 42, fig. 2, *pa.*) form an open angle where they meet, embracing the ends of the vomers; they are then arched and hollow over the inner narial passages, and they thicken greatly at their outer edge, which is emarginate.

Behind, they form an open angle to embrace the fore ends of the pterygoids—their meso-pterygoid region, which does not become cut off, as in most Birds, and in *Anguis fragilis*.

They leave the base of the meso-ethmoidal cartilage exposed below, between the vomers and pterygoids; these bones will also be seen in the sectional views (Plates 44 and 45).

The other palatal element is detached from the palatine and clamps the transverse spur of the huge pterygoid; this "transpalatine" bar is fan-shaped, and its broad part is strongly tied to the under edge of the jugal and maxillary (Plate 42, fig. 3).

With the maxillary, the thin palatal bones form a large oval fenestra on each side, a space very characteristic of the Lacertilian skull; another long, dagger-shaped fenestral space is seen on each side of the parasphenoid, with the pterygoid, outside.

The pterygoids (*pg.*) belong properly to the symplectic fore-growths of the suspensory part of the lower jaw; they reach from the tympanic cavities to almost the end of the vomers, and correspond to all but the broad fore end of the pterygo-palatine of *Proteus, Menobranchus,* and the larvæ of the Perennibranchiate Urodeles.

That primordial generalized bony plate breaks up in various ways, or in the low forms keeps in one piece; in most Urodeles the transverse process of the pterygoid reaches the jugum in the adult.

The counterpart bone in Birds nearly always segments off the front spike to fuse it with the palatine; and in the *Passerines,* the transpalatine is a solid piece of cartilage, which ossifies by ectostosis, and then becomes ankylosed to the palatine.

So that Nature "deals" these morphological "cards" in a great number of ways, and a vast amount of variation is obtained by this shifting, and as it were "shuffling" of things very simple in their nature, and similar in their origin; these matters, well understood, expand our ideas as to what can be done in a high organism by metamorphosis, and greatly help the cause of the "Evolutionist."

From the side (fig. 3), the transpalatine and pterygoid are seen to be locked together, and from thence the pterygoid, having dipped to this point, rises in a concave manner up to the inside of the tympanic notch of the quadrate.

Where the great basipterygoid wings of the basi-sphenoid stand out, there the pterygoids carry a long, oval, cartilaginous facet, the counterpart of that on the cranial spur (*b.pg.*), which gets slightly under the pterygoid (fig. 2, *pg.*, *b.pg.*).

There is a patch of small teeth near the fore end of the pterygoid on its under face, overlapping the palatine articulation.

The manner in which the pterygoids are bowed downwards is showed in the side view (fig. 3), and their outward curve, at the end, is shown in the end view (fig. 4).

These three pairs of bones are properly endoskeletal, but are wanting in their cartilaginous correlates: the rest of the skull is either cartilage, or bone formed by the transformation of cartilage through the medium of *deep* ectosteal laminæ, or imperfect bone—calcified tracts not perfectly changed into tracts of osteoblasts.

The cranium proper is a remarkable structure (Plate 43, fig. 7), which would have been tolerably uniform if the middle pair of sense-capsules had not been free. They modify the cranium for room, pressing it inwards; the other two pairs, nasal and auditory, are completely wrought into the general building.

The hinder third is well ossified, the front part not at all, and the middle or orbital region imperfectly; dry skulls, such as are seen in Museums, hide more than they display.

The occipital arch is ankylosed to the two hinder pairs of the "periotic" bones, the front pair (prootics, *pro.*) are permanently distinct, for the alisphenoids do not ossify as in the Snake and unite with these periotics; yet the three, on each side, keep apart, even in the Snake.

Along the mid line of the roof there is nothing but cartilage or membrane—the great upper fontanelle (*fo.*), up to the very edge of the occipital arch (Plate 42, fig. 4, and Plate 43, fig. 7, *so.*), for the crown of that arch is a plate of cartilage.

The middle part of the skull is a delicate basket of cartilage, only ossified here and there (Plate 43, figs. 2, 7, 8).

All of a sudden, in front, the skull becomes a large swelling mass; this is caused by the fusion, at the mid line, of the nasal capsules with the fore part of the axis.

At its weakest point the cranium is propped up with a bony pole on each side (*e.pg.*); this, however, is a supernumerary element of the mandibular arch, the epipterygoid or "columella" (*not the same as the auditory* "columella," *which is the* epihyal *element fused with the* stapes).

The fusion of the exoccipitals (*e.o.*) with the opisthotics (*op.*) forms the sides of the arch and the large "parotic" or "paroccipital" wings (Plate 42, fig. 4; Plate 43, fig. 7); these parts are characteristically *Lacertilian.*

The broad two-winged key-stone, like the sides of the doorway (foramen magnum, *f.m.*), are seen to contain the canals of the labyrinth; each wing above was a separate

"epiotic," and it has the confluent parts in it of the anterior and posterior semicircular canals (*a.s.c.*, *p.s.c.*).

The rest of the posterior canal, with its ampulla, and the hind part of the horizontal canal (*h.s.c.*), are enclosed in the opisthotic region (*op.*), once a distinct bone.

The ampullæ of the anterior and horizontal canals (Plate 42, fig. 3; and Plate 43, figs. 7, 8, *a.s.c.*, *h.s.c.*), are enclosed in the large high insulated prootic (*pro.*); all these canals being walled in with thin bone, show their elegant curves and swellings on the outside.

The threshold of the great doorway is formed by the basioccipital (*b.o.*), which also forms half of the solid concave floor of the hind skull (Plate 42, fig. 2; Plate 43, figs. 1, 2, 7, *b.o.*) the side-posts and threshold all meet in the substance of the single transverse emarginate condyle (*oc.c.*).

The unossified top of the superoccipital grows as far forwards as the basal plate (*s.o.*, *b.o.*); the latter is a transverse lozenge (Plate 42, fig. 2, *b.o.*) whose obtuse front angle wedges in to the emarginate hinder edge of the basisphenoid (*b.s.*).

On each side, under the suture between the lateral and basal bones, there is a mammillate thickening for the attachment of the flexor muscles.

The 9th and 10th nerves pass through the edge of the exoccipital close to where it has become ankylosed to the opisthotic; the 12th passes out further backwards and higher up: the hole behind its foramen is the "posterior condyloid" (Plate 43, fig. 2, IX, X, XII).

The large anterior periotic bone ("prootic" *pro.*), is in relation below with the basisphenoid (*b.s.*); this latter is a very elegant two-winged plate (Plate 42, figs. 2, 3, 4; and Plate 43, figs. 1, 2, 8, *b.s.*), each of whose fore-turned wings ("basi-pterygoid processes," *b.pg.*), looks forwards and outwards, and is capped with a long oval cartilaginous plate, the counterpart of that upon the pterygoid bone (*pg.*).

The bone rises behind the pituitary body into a transverse "post-clinoid" wall (Plate 43, figs. 1, 2, *b.s.*,), it is then cupped to form the *Sella turcica*, and then ossifies the trabeculæ for a short distance, coalescing there with the feeble parasphenoid (*pa.s.*).

Inside the hind skull (Plate 43, fig. 2) there are two tri-radiate synchondrosial tracts on each side; the upper of these divides the periotic elements, and the lower by its front ray separates the prootic from the basisphenoid, the hind ray separating the opisthotic from the basioccipital, whilst the stem divides the two basal plates.

Here the skull is figured with cartilaginous lines between the bones; further forwards it is made into a lattice-work by cartilaginous bands running along sheets of membrane.

The prootic, a little above its base, has a deep rounded notch in front, where the trigeminal nerve (Plate 43, fig. 2, V) passes out; and behind this is the large "Meatus internus," which is a double within, the facial nerve passing in front, and the auditory (VIII) behind.

Above these passages the bone is sulcate and lies further outwards, more space being wanted for the optic lobes.

Outside (Plate 43, fig. 8), the prootic forms the front margin of the "fenestra ovalis," whilst a spur of the opisthotic divides this from the "fenestra rotunda" (fig. 8, *f.o.*, *f.r.*).

The "foramen ovale" (V) is perfected in front by the alisphenoid (*al.s.*), which is very large as a *region*, but is only marked out, as it were, in cartilage; for there are three large membranous fenestræ enclosed, for the most part, by the alisphenoidal bands (Plate 43, figs. 2, 7, 8, *al.s.*).*

The attempt here to form a continuous cranial "boat," like that of a Shark, Skate, or Frog, is curiously exhibited in the wicker-work, which is continuous along the top, from the front of the orbits to the superoccipital.

In Birds there is always a large gap in front of the alisphenoid, even in *Struthio*; but in some Mammals in an early stage the large extended orbito-sphenoid is continuous with the nasal roof in front, and touches the ear-sac behind. (See ESCHRICHT, 'On *Balæna Japonica*, Lac.'; Copenhagen, 1869, plate 2, figs. 1, 2, *k.*; and my paper on the "Pig's Skull," Plate 34, fig. 6, *o.s.*).

But in these cases the alisphenoid is small, and does not come near this upper band, for the *lesser wings*, in most Mammals, are much larger than the "alæ majores."

In the Bird the fenestra is in the centre of the alisphenoid, but in *Lacerta* not one of the *three* fenestræ is finished by the alisphenoid itself.

The upper band of cartilage runs from the upper lobe of the forked orbito-sphenoid (*o.s.*) to the rounded notch on each side the superoccipital (Plate 43, figs. 7, 8); this cartilage overlaps the prootic, and keeps distinct from it. Under this bar there are two large squarish fenestræ; the first is bounded in front by the orbito-sphenoid, and behind by the main long ascending bar of the alisphenoid.

The second is bounded in front by that bar, and behind by the bony prootic.

The third is under this, and is bounded in front by the bony part of the main ali-

* I have long been familiar with these narrow tapes of cartilage in the smaller Lizards (*Centropyx calcaratus*, *Anolis* sp., *Mocoa* sp.), but until lately I failed to catch their meaning. I have not yet seen any cartilage in the alisphenoidal region of the Chelonia, and in the Chamæleons (old and new-born) there is only a narrow stem, ossified in its lower half, close behind the septum orbitarum.

In the 'Morphology of the Skull' (p. 216), Lizards are said to have no alisphenoid; and Professor HUXLEY ('Elem. Comp. Anat.', p. 226, fig. 91, *b.*) says of the narrow bony alisphenoids of the Iguana, that they "appear to represent the orbito-sphenoids."

Misled by a fallacious analogy, that of the Mammal's orbito-sphenoid, where there is a bony bar behind the optic nerve, I accepted this suggestion as the truth. Any Bird's skull might have undeceived me, where the skull, so much more specialized and yet truly reptilian, never shows any trace of an "anterior sphenoid" behind the optic foramen. In Carinate Birds the alisphenoid is largely membranous; it is constantly fenestrate (in the young) in the centre, and the foramen ovale is really a large fenestra ("Fowl's Skull," Plate 83, fig. 2, *as.*, *as.f.*), but the orbito-sphenoidal wings are aborted in all but *Struthio camelus*, even in the "Ratitæ;" and the space is filled by one or two membrane-bones on each side. Thus the alisphenoid of the Bird is always free in front, although it is continuous with the cranial crest of the auditory capsule behind.

sphenoidal bar, below by the basisphenoid, and above and behind by a sinuous creeping branch of cartilage that forks off from the main, front bar (above its ossified part, where it turns outwards, to ascend to the upper band), grows *backwards* until it touches the anterior ampulla (*a.s.c.*) and then runs down in front of the trigeminal nerve.

This creeping, posterior bar unites with the basisphenoid, after perfecting the *foramen ovale* (V); the *main, front* bar, of the alisphenoid unites with the trabecula by a forked process, close behind the common optic "fenestra" (II). The widest part of the cartilage is at the top, behind; to it is tied the cartilaginous top of the bony post (epipterygoid, *e.pg.*).

The lower, well ossified part of the main bar, behind the optic nerves, is always seen in dry skulls of the Lizards, but the cartilaginous parts are seldom seen.*

The rest of the cranio-facial axis of *Lacerta* is as instructive as the posterior sphenoidal region: it is curiously like, and curiously unlike, that of the Bird.

The orbito-sphenoid (*o.s.*) is much larger than in the embryo of *Struthio*, and is deeply notched in front. At its root it is narrow, and only at that part is it joined to the presphenoid; its hind lobe is continuous with the alisphenoid, at the top; and the sharp, lesser, long, front, lobe ends in a free point a little way behind the nasal wall (Plate 43, figs. 2, 7, 8, *o.s.*, *p.e.*).

The presphenoid runs from the optic foramen (II) to the ethmoidal region (*p.e.*), which is partly marked off by a rudiment of the fenestra—the familiar cranio-facial cleft, of the Bird (figs. 1, 2, *c.f.f.*).

This "fenestra," which does not exist in the "Ratitæ," but appears in some of the semi-struthious *Tinamous* ("Ostrich's Skull," Plate 15, fig. 8), and in the Chick by the end of the second week of incubation ("Fowl's Skull," Plate 83, fig. 4), is also present in the Australian Stump-tailed Lizard (*Trachydosaurus rugosus*), but not in the Chamæleon.

Here, it has only a morphological meaning; in the Bird it helps to finish a series of the most marvellous metamorphic specializations ever seen in the Vertebrate skull; in the Crow, the Parrot, and the Toucan, its final meaning comes out with its *finish* in the cranio-facial hinge.

The very constant interorbital fenestra of the highest "Sauropsida" is here in *Lacerta*. It is a large, superior interorbital notch (*i.o.n.*), larger than the notch behind, where the optic nerves pass out. The slanting stem of the presphenoid becomes partially ossified in age (Plate 43, fig. 8, *p.s.*); and there is some bony (endosteal) deposit under those nerves.

* After more than twelve years, the small distinct ali-and orbito-sphenoids of the Snake ("Snake's Skull," Plate 29, fig. 5, *al.s.*, *os.*) cease to be inexplicable to me; they are, in that arrested chrondocranium, mere patches of what is seen in *Lacerta*. The Snake's alisphenoid is just so much as lies in front of the exit of the 5th nerve in *Lacerta*, and its orbito-sphenoid, a rudiment of that of the Lizard, behind the forks.

From the pituitary fossa to the end of the snout, the coalesced trabeculæ are marked as the thick, rounded, lower edge of the orbito-nasal septum.

In front of the ethmo-presphenoidal fenestra (*c.f.f.*), this wall is thickened, rises higher, and then gradually lowers forwards; at its highest part it is fused with the nasal roof (fig. 7).

The sudden rise of the septum is due to the fact that there is an olfactory recess, as in "Mammals," where the first pair of nerves are given off to the nasal mucous membrane (fig. 7, I); there is, however, no *crifriform plate*, but merely a single aperture on each side of the septum.

A little further out, under the floor of this recess, the orbito-nasal nerves (V^1) are seen to pass on their way to the front of the snout.

The winged top of the septum—the wings are the nasal roofs—ends in front of the basal part, which retires a little, and is emarginate in the front (Plate 43, figs. 1, 2, *s.n.*); the thickening above is where the roofs have been cut away; the notch below is caused by the bend of the trabeculæ.

The vomer, septo-maxillary, and nasal glands (fig. 1, *v.*, *s.mx.*, *n.g.*), here rise upon the side of the septum; the upper bone is the one mistaken for the *inferior turbinal*: a true cartilaginous rudiment of which I shall soon describe.

I may now, before passing on to the transversely vertical sections, recapitulate the open spaces to be seen in this curious cranial basket.

Above (Plate 43, fig. 7), there is the great fontanelle (*fo.*), ending in the rounded notch on each side of the rostral cartilage of the superoccipital (*s.o.*). This space is imperfect in front, and for the most part is hourglass-shaped, being pinched in by the "epi-pterygoids." Where this fontanelle ends in front, over the olfactory recess, there are the olfactory foramina; under this part, those for the orbito-nasals (V^1); the right and left fenestræ in the nasal roof (*ol.f.*); and the external nostrils (*e.n.*), laterally.

Most of the passages and spaces can be seen inside a half-skull (Plate 43, fig. 2), but only on the outside can be seen the auditory fenestræ (fig. 8, *f.o.*, *f.r.*); and the nerve passages, behind, not so clearly.

But in the section (fig. 2) there are, on each side of the foramen magnum, or great doorway, the posterior and anterior condyloid foramina, the double hole for the 9th and 10th nerves, the double "Meatus" for the 7th and 8th, the large "foramen ovale" (V), the great lower fenestra between this and the alisphenoidal stem, and a hole at the base of that stem. Above, from the prootic forwards, two great fenestræ and one great notch; below, the common optic fenestra (II), the orbital notch (*i.o.n.*), and the cranio-facial fenestra (*c.f.f.*).*

The large, bulbous, fenestrate nasal labyrinth (Plate 43, fig. 7), with the pedate antorbital rudiments of the ethmo-palatine bars (*e.pa.*), will be only understood by

* I scarcely need refer to my recent description of the skull of the Snake—a hard solid case, the extreme contrast of this little Lizard's Skull, but made of the same clay, and the same bricks and tiles.

reference to the transversely vertical sections, and the rest of the skull will have its meaning greatly elucidated by the series of these illustrations (Plates 44 and 45).

The 1*st* of these (Plate 44, fig. 1) is in front of the outer nostril (*e.n.*), it shows the terminal divergence of the trabeculæ (*c.tr.*) into "cornua;" the height of the septum up to the front of the face, and the size and sweep of the nasal roofs (*ol.c.*), as they turn in with a sigmoidal bend, below the recess in front of the outer aperture (*e.n.*).

On these roofs lie the nasals (*n.*), which dip between them; below, we see the foremost part of the maxillary (*mx.*), and the lateral and median (palatine) parts of the premaxillary (*px.*); also, on each side of the lower part of the septum nasi the septo-maxillaries (*s.mx.*) are cut through, and on each side of the cornua (*c.tr.*) the vomers (*v.*).

The 2*nd* section (fig. 2) is through the outer nostril (*e.n.*); there the nasal roof is seen partly severed below, and both the median palatine processes of the premaxillary and the cornua trabeculæ are at their thickest part.

The 3*rd* section (fig. 3) is behind the nostrils; here the deep septum (*s.n.*) is thin below, behind the diverging cornua trabeculæ; but it thickens where it is clasped by the increasingly wide septo-maxillaries, below the nasal channel.

The nasal wall thickens greatly below, where it is applied to the outer face of the nasal gland (*n.g.*), which is cut through in this and the next sections.

Below we see a pair of cartilaginous bands, in section, that can be traced to the ant-orbital region (figs. 3–9, *n.f.*).

This extension of the back of the capsule forwards to the front passage, as an obliquely placed tape of cartilage, reappears again in certain *ancient* types of birds, *e.g.*, in *Turnix* and in *Chasmorhynchus.* ("Ægithognathæ," Part I., Trans. Zool. Soc., vol. ix., plates 54 and 62.)*

The nasal wall is beginning to bend inwards to make room for a mass of sub-cutaneous follicles, which become collected into a glandular mass inside the inferior turbinal (see figs. 6 and 7).

The nasals, septo-maxillaries, vomers, and maxillaries, are all larger in this 3*rd* section, and the latter shows a *new* tooth inside of the *old* one, at the margin.

The 4*th* section can only be interpreted by the help of what was made out in the simpler and less specialized skull of the Snake ("Snake's Skull," Plates 32 and 33, pp. 411–414); and, indeed, the worker has to borrow largely from the Serpent, if he is to have understanding to count the number, and to tell the meaning of the parts in this small skull, which is a fulfilment of all that existed before it, and a prophecy of all that will come after it, in the Vertebrate cranium.

The trabecular or lower portion of the septum (*s.n.*) is thickened, but forms a sharp keel below; the nasal walls (*ol.c.*) bend in still more than in the last, and then become abruptly thick below, where they have become confluent with a large, thick, half-coiled

* That the Bird is a sort of morphological "Imago" to the more arrested, *quasi-pupal* Lizard, will only be questioned by those whose knowledge of the structure of these creatures is in a very rudimentary state; or by those, "who, having eyes, see not."

"upper labial" (*u.l.*), a part separate in the Snake, or now and then confluent, in front, with the cornu trabeculæ.

As in the Snake, this labial turns by the side of the duct, into the hilus of the gland (*n.g.*); here the septo-maxillaries (*s.mx.*) are at their widest part, and the vomers (*v.*) below are widening.

Over the vomers we see the shelving nasal floor (*n.f.*), supported by the vomers; the nasal bones (*n.*) and the maxillaries (*mx.*) are larger than in the last section.

In the 5*th* section (fig. 5), the nasal walls are much more bent inwards, and they turn outwards again to reach the facial wall; they thicken, turn inwards suddenly again, and then we see how much they owe to the large upper labial (*u.l.*). I cannot tell whether there was another labial here, as in the Snake, or only one, as in the Bird.

Each vomer (*v.*) here is in two parts, the section having been made through its notch for the duct of the gland and the ingrowing labial cartilage; the septo-maxillaries (*s.mx.*) are tapering; the nasals and maxillaries (*n.*, *mx.*) are widening; the nasal gland (*n.g.*) is at its hinder face.

The 6*th* section (fig. 6) is through the curious fenestræ in the upper surface of the nasal capsules (Plate 43, fig. 7); the cartilage of the *roof* is wide apart from the cartilage of the *wall*; the labial cartilage has been passed, but the narrow floor (*n.f.*) is there.

The razor has passed through the widest part of the vomers (*v.*), behind the septo-maxillaries and nasal gland, and in front of the prefrontal (see fig. 8, *p.f.*).

Here the trabecular base of the septum (*s.n.*) is rounded again, and the septum itself is more evenly thick, as compared with the last section.

The inturned nasal wall, separate from the roof, has closed in upon the glandular follicles, and the stem of this tube—the "inferior turbinal" (*i.tb.*)—is short, with a pedate root or base.

The 7*th* section (fig. 7) shows the same thing, but the *turbinal tube* is more constricted, and begins to show some of the solid cartilaginous mass into which it passes on the front of the antorbital (*post-nasal*) wall; this is the last section in front of the "olfactory fossa" (Plate 43, fig. 7, I).

The 8*th* section (fig. 8) was made behind that fossa, but the thick fore part of the antorbital plate was shaved through; the marks of the hind part of the glandular mass are seen upon the ear-shaped plate, which is the end of the inferior turbinal (*i.tb.*).

Above, this section is close behind the nasal roof and olfactory recess (Plate 43, fig. 7, I). *Seven* cartilages are cut through, and the outer bones are not the same as in the last, for we are now behind the naso-frontal suture, and the frontal (*f.*) and pre-frontals (*p.f.*) come into this section.

If this figure be compared with the upper and side views of the endocranium (Plate 43, figs. 7, 8), we shall see how imperfect the cranial cavity is in front.

The median wall is thick throughout, and stands alone, flanked below by the

narrow oblique floor bands (*n.f.*); there is only so much of the wall as serves to hold the inferior turbinal (*i.tb.*) in place.

The hemispheres (C^{1a}) are cut through their fore part, over the origin of the olfactory crura. (See Plate 43, figs. 1 and 7, I.)

There is no cartilage either in floor or roof at this part of the cranial cavity, with the exception of a narrow band on each side the upper inturned part of the antorbital wall (*p.p.*) and the narrow bands inside the floor (*n.f.*). (See figs. 9, 10.)

If we compare this figure with those of the perfect skull (Plate 42, figs. 1 and 3, *f.*, *p.f.*, *mx.*), we shall find that the maxillary reaches the frontal, and the prefrontal crops up close behind the highest part of the large facial plate of the maxillary.

The next two sections (9*th* and 10*th*, figs. 9, 10), are through the cranio-facial fenestra (see Plate 43, figs. 1, 2, *c.f.f.*), so that the septum—"meso-ethmoid"—is now seen as two rounded parts.

In both, the prefrontal has gained the roof, and wedges in between the frontal and maxillary, and the thick frontals are now growing into the side of the skull, resting obliquely on the prefrontal plate.

Below, the vomers (*v.*) are still large, and the maxillaries (*mx.*) form a strong wall, and a good piece of the floor.

In the 9*th* section the antorbital plate (*p.p.*) or "pars plana" is cut through so as to give a zig-zag band of cartilage; but if we compare this with figs. 8 and 10 we shall see its meaning.

This section shows well that the antorbital cartilage or *back wall* of the nasal capsule grows inwards and forwards against the septum nasi, but is soon reduced to a narrow band in the inner part of the floor, which band runs forwards to the 3*rd* section (fig. 3, *n.f.*).

The large leafy antorbital wall is a curved axe with a short helve; this helve which is pedate, rests upon the palatine plate of the maxillary, with the "toe" inwards and backwards, and the "heel" outwards and forwards.

That this cartilage should be united to the nasal wall by a narrow isthmus, and should rest upon the palatine plate of the maxillary, so accurately turning its "toe" inwards and backwards, and its "heel" outwards and forwards, is quite normal and in accordance with the morphological laws governing these things.

This cartilage is well known to the student of the "Ichthyopsida," and once known well in them can be interpreted and understood under all sorts of forms and disguises; it is the rudiment of the 2nd præ-oral or palatine arch, and is indifferently called the "antorbital" or "ethmo-palatine" cartilage; its main splint or investing bone is the maxillary, which bears the same relation to it that the "dentary" does to MECKEL'S cartilage—the main *splint*, and the *axis*, of the mandible.*

* I was once, for a time, sceptical as to the independent existence of this arch; the Tadpole, in which it is suppressed, *for a time*, making me waver. Professor HUXLEY also, for a time, strongly protested against its existence. Now, however, besides my own carefully long-linked chain of morphological details, I can

The malar or jugal is its second splint: in the Lacertilia generally there are no others; inside the jugal the endoskeletal part is absent.

The isthmus connecting the cartilage with the nasal wall is a secondary or conjugational part; the "heel" is the distal end of the arch, the "toe" the rudiment of the sub-ocular bar.

This rudiment is well seen in the Chamæleon—the most aberrant form of the Lizard—but not in the Snake; in the Birds it can frequently be found.

In the "Ratitæ" it does not ossify ("Ostrich's Skull," Plate 10, figs. 1, 4, 10, 18; and Plate 14, figs. 1 and 7, *a.i.t.*), but in the "Carinatæ" it is ossified as the "os-uncinatum," and is well seen in *Musophaga, Corythaix, Trogon,* and *Scythrops*; in the "Psittacidæ;" in Psittaciform Finches, *e.g., Coccothraustes*; in *Dicholophus*; in the "Laridæ;" and in *Diomedea.*

In the "Ichthyopsida" it is well developed in the Batrachia, although not often distinct from the pterygoid cartilage; in the Urodeles it is distinct, but generally fuses with the ear-capsule.

In the higher "Ganoids" it has evidently become fused with the pterygoid, but has its own bony centre. (See TRAQUAIR on *Polypterus,* 'Journ. of Anat. and Phys.', vol. v., plate 6, fig. 6, *pl.*; and BRIDGE, on *Amia,* ibid., vol. xi., plates 23, fig. 6, *pl.*).

I am somewhat doubtful of it in *Acipenser* and *Polyodon*; in the Sharks it is rudimentary, is distinct in *Notidanus,* and large in all the Skates.

In every case, even where, as in the Skates, it is most developed, the eyeball thrusts it out from the basis-cranii, and has manifestly robbed it of its segmental nerve (the third or "motor oculi"), and has left it to its own moiety of the 5th, and to a wandering branch of the 7th, the "vidian" nerve.

The 11*th* section (Plate 45, fig. 1) is through the fore part of the eyeball (*e*), and the widest part of the palatine bones (see Plate 42, fig. 2, *pa.*), where they overarch the narial passage (*i.n.*).

The septum (now the "ethmoid") is complete here, but enlarged above and below; near it, above, we see the narrow front fork of the orbito-sphenoid (*o.s.*). (See also Plate 43, figs. 7 and 8, *o.s.*)

In this section the foremost large, and a smaller, superorbital (*s.ob.*) are severed; and the jugal process of the maxillary (*mx.*) is seen under the eyeball.

In the 12*th* section (Plate 45, fig. 2), both the upper and lower forks of the orbito-sphenoid (*o.s.*) are severed, and the interorbital notch (*i.o.n.*) is shown in the deficiency of the mid-wall above.

bring the evidence of the best experts on Embryology as to the presence of a true visceral arch over and in front of the mouth (see BALFOUR, 'Elasmobranchs,' plate 14, pp. 211–216, where the *head cavities* are shown to be continued in front of the mouth; and MILNES MARSHALL, 'Quart. Jour. Micr. Soc.,' vol. 18, new series, plates 2, 3, pp. 1–31, who shows that the *3rd nerve* is as good and clear a "segmental" nerve as the trigeminal). I have another—the foremost visceral rudiment in front of the palatine—ready for acceptance as soon as this is disposed of.

Here the narrowing palatines are seen to overlap the pointed fore end of the pterygoid (*pa.*, *pg.*), and the jugal is obliquely severed over the maxillary (*j.*, *mx.*). This section shows no more of the prefrontal, for it is through the crystalline lens, but it shows the size and strength of the frontal and superorbital roof bones (*f.*, *s.ob.*).

The 13*th* section (fig. 3) is through the post-orbital region, the widest part of the hemispheres (C^{1a}) and the optic "Chiasma" (II), here the notched back of the sinuous inter-orbital septum (presphenoid, *p.s.*) is cut through, and the upper unossified stem of the alisphenoid (*al.s.*); the bony stem has just been missed and is indicated by dotted lines.

Over the whole we see the hind part of the frontals, the super- and post-orbitals, and the jugals (*f.*, *s.ob.*, *pt.o.*, *j.*); below, the pterygoid (*pg.*) comes into view.

The 14*th* section (fig. 4—more than half) is through the mid brain (C^2) in front of the exit of the 5th nerve and behind the 2nd, and close in front of the pituitary body. Simple as this section seems in the figure, it is full of interest, for it displays some of the most remarkable things seen in the skull of a *Sauropsidan*, or indeed of any Vertebrate whatever.

The trabeculæ are severed in the *pro-clinoid* region, before they have coalesced, as they do, a little further forwards, to form the base of the orbito-nasal septum.

There are two other basicranial elements at this part, for the basisphenoid (*b.s.*) has here coalesced with the small *rostral* parasphenoid (Plate 43, figs. 1, 2, 8, *pa.s.*); and it is worthy of remark that this is the exact place at which the parasphenoidal rostrum *grafts itself* upon the converging trabeculæ or becomes *ectosteal*, in the Chick, at the middle of incubation ("Fowl's Skull," Plate 82, figs. 1, 2, 3, *bs.*).

Outside the bone (*b.s.*) a thick plate of cartilage has been cut through, then there is a synovial cavity, and then outside that another similar plate of cartilage.

This is precisely what takes place in the Chick (ibid., Plate 83, figs. 13, 14), which differs from the Ostrich ("Ostrich's Skull," Plate 7, fig. 4; Plate 8, fig. 2, *ap.*) in having a *new segment* of cartilage superadded to the basis-cranii on each side, the distinct equivalent of the "basi-pterygoid," which grows directly out from the trabecula on each side in the Python, Boa, Ostrich, Guinea Pig, Sheep, &c., and which in the Pig rises up the side of the alisphenoid and becomes the "external pterygoid plate" ("Pig's Skull," Plate 34, fig. 2).

In those Carinate Birds that develop the basi-pterygoids for articulation with the lateral facet of the pterygoids, namely, Fowls, Geese, Pigeons, Plovers, Petrels, Owls, &c., these parts are developed as in this Lizard, in which I expected to see a *generalized condition* of these parts, as in the Ostrich.

The pterygoid (*pg.*) here, also, acquires a facing of articular cartilage on its upper surface, and another joint cavity for a stem of bone ending in cartilage, both above and below—the "epi-pterygoid" (Plate 42, fig. 3; Plate 43, figs. 1, 2, 7, and 8; and Plate 45, fig. 4, *e.pg.*).

This bone, which thus rests upon the pterygoid and props up this *weak* skull, is here

developed to the highest pitch; it is suppressed in the Chamæleon, and small in the "Chelonia."

For many years I have been familiar with this bone so far as it is seen in Reptiles, but its *genesis* was hidden from me; by naming it simply from its *position*, I named it truly. CUVIER named it from its *form*, and the same name, also, was given to the auditory stapedial stem, namely, "columella"—a name which can only be retained for the last ossicle.

But in working out the skull of the Axolotl, and tracing it into that of the Amblystoma ("Skull of Urodeles," Plate 27, fig. 7, *e.pg.*, p. 566), and also in working out the Menopome, the Newt, and other kinds of tailed Amphibia, I came upon its true (very simple) morphological meaning.

In those forms, which in their larval state are but a step beyond the "Dipnoi," we can find the correlation of the outer and inner skeletal elements, as they are becoming attracted to each other, by what may be called *organic affinity*.

The large *symplectic process* of the mandibular suspensorium, the pterygoid cartilage, has no development in the lowest forms of "Urodeles," namely, in *Proteus* and *Menobranchus*, and it appears rather late in the larvæ of the higher (metamorphic) kinds.

The bony (pterygoid) plate in these low forms and in the young larvæ of the higher kinds, is not distinct from, and grows as a process of, the dentigerous "palatine," close to the corresponding dentigerous vomer—two patches of teeth, bound together by spreading bone, and entirely independent, at first, of the chondrocranium.

The process from the bony palatine which grows backwards to meet the pterygoid cartilage as it grows forwards, is then fretted off from its bony root, soon applies itself to the cartilage, metamorphoses much of it into bone, but carefully, in most cases, leaves a small, obliquely-placed rod, unossified; this tract was once a separate post-palatine.

This rod, lying in a groove of bone, becomes an ennucleated rudimentary "epi-pterygoid," and the gentlest metamorphic touch, sheathing it with an independent film of bone, would give us the exact counterpart of the Chelonian "epipterygoid."

In the Lizard, as we shall see in the 6*th* or penultimate stage, this part, and the two plates of cartilage on the pterygoid (a membrane bone), are all the cartilage we find in the *symplectic region* of the Lizards' mandibular suspensorium; the foot-shaped antorbital cartilage belongs to the next, or palatine arch.

Note also, that here, where the symplectic or pterygoidean parts are so largely developed, we have, as a correlate, the suppression of the "orbital process" or "pedicle" of the mandibular pier, only the "otic process" appears, on the quadrate (Plate 42, fig. 3, *q.*).

In the Chelonia, where the epipterygoid is small, the "pedicle" is small, but distinct; in Birds, where the epipterygoid is never more than an ascending process or hook ("hamular process"), there the pedicle or orbital process of the quadrate is very large, nearly as large as the otic process.

This separation of the conjugatory or symplectic region of the upper mandibular element is the exact morphological repetition of what takes place in the hyoid arch, in its relation to the mandibular, in the "Chondrosteous Ganoids," as *Acipenser* and *Polyodon*. (See "Sturgeon's Skull," 'Monthly Micr. Jour.', June, 1873, Plate 20, fig. 1, *sq.*; TRAQUAIR'S "Ganoid Fishes," Part I.—*Palæoniscidæ*—Palæontographical Society, 1877, plate 7, fig. 1, *sq.*; and BRIDGE on *Polyodon*.)

That is the last degree of specialization of these two post-oral arches in their relation to each other in the formation of a protractile and retractile mouth.

In the Lizard the upper mandibular element becomes, as we have just seen, equally metamorphosed in relation to the parts above and in front of the mouth, the arrested palatine arch receiving copious supplementary growths from the pier of the mandible.

In this (4*th*) section the upper and lower bands of the alisphenoid (*al.s.*) are cut through; and below the lower bar the three branches of the trigeminal nerve (V) are seen.

The surangular, angular, and articular (*s.ag.*, *ag.*, *ar.*, *Mk.*), are shown in section below; the thick, proximal part of MECKEL'S cartilage is not all ossified.

The larynx lies forward on the long tongue; thus we see the trachea (*trc.*) lying over the basihyal (*b.hy.*); part of the ceratohyal (*c.hy.*) is shown further outwards.

The 15*th* section (fig. 5) is through the fore-part of the tympanic cavity (*c.ty.*), the Gasserian ganglion (V), the anterior semi-circular canal and its ampulla (*a.s.c.*), and the wide part of the basisphenoid (*b.s.*), where the basi-pterygoid processes (*b.pg.*) are behind the cartilaginous facets.

The prootic (*pro.*) articulates with the basisphenoid (*b.s.*) below the foramen ovale (V), and runs to a sharp edge above (see also Plate 43, fig. 8). The two bands of the alisphenoid (*al.s.*) are shown, and the lower of these is cut through where it lies in front of the ganglion (V). The conchoidal quadrate (*q.*) is hollowed to form a recess for the drum of the ear; the tympanic membrane and the articular part of the jaw and the joint-cavity are shown (*m.ty.*, *ar.*).

But the drum of the ear, its parchment, and the rod that makes it tense, are better shown in the 16*th* section (fig. 6).

The skull is here cut through in its hinder part, through the occiput; the super-occipital, joined to the epiotics (*s.o.*, *ep.*), the exoccipitals (*e.o.*), and the broadest part of the basioccipital (*b.o.*), are shown. The canal cut through above is the posterior (below *ep.*), just behind its junction with the anterior; the horizontal canal (*h.s.c.*) is cut across behind its ampulla (see also Plate 43, fig. 8).

This fortunate section shows the relation of the middle to the inner ear, perfectly; under the "tegmen tympani," formed by the bulging of the horizontal canal, the columella is shown, its stapedial plate (*st.*) being cut across as it fits into the fenestra ovalis.

The medio-stapedial bar (*m.st.*) runs outwards and a little downwards; one ossification served for this bar and the proximal plate (*st.*).

This section can be conveniently studied with the details given in Plate 43,

(figs. 3, 4, 6). The bony bar ends in cartilage, the outer part of the stem (nearly half) is unossified, and there is a large trifoliate growth of cartilage abutting externally against the tympanic membrane (Plate 43, figs. 3, 4, 6 ; and Plate 45, fig. 6).

The "middle ear" in this Lizard is typical of what is seen in all the Sauropsida above the Serpents;* and therefore is worthy to be worked out exhaustively, and described fully.

The position of the columella, stretching from the fenestra ovalis to the membrana tympani, is seen also in Plate 43, fig. 4 ; in fig. 3, the extra- and infra-stapedial cartilages are seen from the outside ; the former is seen through the membrane, which is stretched upon the rim of the hollowed quadrate (*q.*), and the latter is seen to escape from the drum-cavity, as if it would unite with the stylo-hyal (Plate 45, fig. 6, *i.st.*, *st.h.*), which it does in *Hatteria* (HUXLEY, *op. cit.*, p. 397), and in the Bird. (See "Bird's Skull," Part II., Trans. Linn. Soc. (Zool.) vol. i., plate 20, fig. 7.)

As in many Birds the supra-stapedial (*s.st.*) is bilobate, the outer broad lobe being a continuation upwards of the tongue-shaped extra-stapedial (*e.st.*) ; the inner lobe, the true supra-stapedial, as in *Hatteria*, and many of the Batrachia (*e.g.*, *Rana pipiens*) is united to the ear-capsule by cartilage. Here it is almost fibrous at the middle where it thins out.

The "stapedius" muscle arises (fleshy) from the outer part of the paroccipital process (opisthotic and exoccipital combined), and is inserted (fleshy) between the outer broad, and the inner narrow, lobes of the supra-stapedial (Plate 43, figs. 4, 6, *st.m.*).

In this section the facial nerve (VII) is seen passing out *over* the columella ; the fenestra rotunda leading to the rudimentary cochlea is seen in the side and end views (Plate 43, figs. 4 and 8, *f.r.*).

Here, as in the Tortoise and Crocodile, the os quadratum is hollowed out to form the ear-drum ; in the Bird that bone is pneumatic, and opens into the drum, but the main part of the cavity is formed by a hollow shell-like wing of the exoccipital (par-occipital), the floor being formed by the basitemporal, and the roof by the tegmen tympani and squamosal ; in many Birds there is a chain of tympanic bones that serve to strengthen the ring of the parchment : these parts are attached to the quadrate in some degree.

The endoskeletal part of the mandible, *e.g.*, quadratum, articulare, and MECKEL's cartilage, have already been partly described ; the quadrate is seen in the side view (Plate 42, fig. 3, *q.*), and from the end obliquely (Plate 43, figs. 3, 4, *q.*). A low broad ridge divides the conchiform hollow ; the head or "otic process" articulates with the squamosal (*sq.*) ; and below, there is a bilobate convex condyle for the lower jaw.

* See HUXLEY, Proc. Zool. Soc., May 27, 1869, and my papers on the Birds' skull, namely, "Ostrich's Skull," Plate 12 ; "Fowl's Skull," Plates 81 and 87 ; also "On the Skull of Woodpeckers and Wrynecks," Trans. Linn. Soc. (Zool.), second ser., vol. i., plate 1 ; and "On the Skull of Birds," Part 2, ibid., vol. i., plates 20 and 23.

The concavity of the lower jaw is shallow and sinuous; the articulare has a considerable angular process, and the bone itself is seen most on the inside (Plate 43, fig. 2, *ar.*); MECKEL'S cartilage is reduced to small dimensions within the splints.

The other post-oral bars are very slender (Plate 42, fig. 5), the stylo-ceratohyal (*st.h.*, *c.hy.*) runs up to the side of the ear-capsule, just below the fenestra (Plate 45, fig. 6, *st.h.*), and then passing downwards and forwards, it enlarges into an ear-shaped lobe in the cerato-hyal region.

The hypohyal (*h.hy.*) is short, and turns suddenly backwards; where it articulates with the basihyal (*b.hy.*) that bar is wide and shows no separate joint behind this articulation; the rest of the median rod is very long and slender: it is the skeleton of the protrusible tongue.

Both the hypohyals and first branchial bars ($br.^1$) are scarcely distinct from the basal piece; the latter are long and elegantly sigmoïd with the distal three-fifths ossified, and the proximal part pointed and turned inward.

Another bar, half as long as the first, and unossified, lies behind the first branchial above; it is *f*-shaped, with the top hooked inwards, like the lower piece; this is the upper ($br.^2$), or "epibranchial" part; it has a small snag outside its middle.

Besides this, there is on each side, a slender, slightly outbent hypo-branchial (*h.br.*), this belongs to the second branchial, and also from its length is evidently part of the *third*, neither of which chondrify, above, in the embryo.*

First Stage. Embryos of Lacerta agilis $2\frac{1}{2}$ *lines* ($\frac{1}{5}$*th of an inch*) *long, measured along their curve.*

To prevent misconception as to *size*, I may mention that the embryos of large types of any class are much smaller, relatively, than those of small species.

For instance, my *third stage* of this minute species corresponds exactly to young embryos, in my possession, of the Green Turtle (*Chelone viridis*); these are only *half an inch long*, whilst those of *Lacerta agilis* measure *five-twelfths* (5 lines); thus they are only *one-twelfth* of an inch shorter than the embryos of that gigantic Reptile.

Again, the embryos of the Common Pig, figured in my paper in the Philosophical Transactions for 1874 (Plate 28, figs. 1–3), scarcely measured *two-thirds* of an inch, whilst similar embryos of the Common Mole (*Talpa Europæa*)† are *three-fourths* of that length, namely, about *half an inch*.

Another thing to be noted is this: that in both those cases, the Turtle and the Mole, these, my younger specimens, can be seen to belong to those types; the embryos of the

* So that we are but just escaping from the *branchiate* Vertebrata; the *Pipa Toad*—with its *four* "extra-branchial" bars, and branchiæ so fugacious that my early embryos ("Skull of Batrachia," Part I., Plate 60, figs. 1, 2) had lost them—is an outsider of the "Branchiata;" and this little, highly-metamorphosed Lizard, has scarcely thrown aside the skeleton of these organs of aquatic respiration.

† The gift (with several other stages) of T. SOUTHWELL, Esq., of Norwich.

Turtle are manifestly *Chelonian*; and those of the Mole have their fore-paws very large, and lying on each side of the skull. They could be mistaken, even at that early stage, for the embryos of no other Vertebrate.*

My smallest embryo of *Lacerta agilis* (Plate 37, fig. 1), is, if anything, a little less developed than the smallest embryo of the Snake ("Snake's Skull," Plate 27, figs. 1, 2); *that*, rather, would answer to the *second* stage of the present paper (Plate 37, fig. 2).

I am careful to give all these details minutely, so that a harmony may be made of these early conditions in various Vertebrata; my *stages* are quite arbitrary, answering to my *materials*.

Even in so small an embryo as my youngest (Plate 37, fig. 1), the organic processes have been busily at work, and the main parts are already to be seen in rudiment.

The head is very large, relatively, and the "cephalic flexure" is perfect, throwing the mid brain (C^2) outside the line of the general curve of the embryo.

That, and the fore brain (C^1) are nearly of a size, but this vesicle sinks down between the eyeballs, and is not so apparent: moreover, the hemispheres are budded from it in front and are seen as a pair of swellings; the *optic vesicles*, also, have grown from the fore brain, and are shielded by a fold of skin.

The hind brain (C^3) is longer than the others, it is also narrower, less convex, being somewhat crested above, and sub-lobulate; it is, however, larger than it seems, being hidden between the right and left hind face.

The whole embryo forms nearly a circle, the tail almost touching the head; the two regions, head and body, are about equal in length, but in bulk the head greatly preponderates.

There is much invaluble knowledge to be gained for morphology in a germ like this, without dissection, and I shall, without poaching on the embryologist's preserves, gather what I want from the outside of *his* subject; in a further stage (the third) I shall join hands with him on the headland which is common property.

In the parts that belong to the head, *segmentation* is indicated most clearly by the clefts formed in the *sub-ventral* region of the sides; behind the head, the divisions between the "somatomes" are evident in the *sub-dorsal* region; of these, at present, I can count about thirty.

At present, by the help of the clefts, I can only find *six* visceral folds or cephalic segments; the last of these is imperfect, and one more, in front of the face, appears afterwards.

These are all there will ever be, and the last, or seventh, is aborted long before the embryo is ripe; as for segments, such as those in the body, which are indicated by the evident "muscle-plates," *two*, or at most *three*, can be found in each side of the notochord, in front of the first vertebra.

The "head cavities" will be treated of in the third stage; they are invaluable land-

* It is beyond my province to explain this fact; I leave its interpretation to others.

marks—truer than the *nerves,* which are so much specialized,—but even Mr. BALFOUR has not found these in the fronto-nasal region, where there seems to be a rudimentary first pre-oral segment formed.

In the specimen figured, the "amnion" and yolk-sac were removed, but the budding "allantois" (*all.*), as large as the pericardium (*pcd.*), was left *in situ*, and figured.

That large diverticulum of the "splanchnopleure," the pericardium, is a round ball, showing through its thin sides the heart (*h.*) as a looped vessel, subdividing and filling most of the concavity between the arched spine on one hand, and the snout and tail on the other.

The fore limbs (*pt.l.*) are oval buds from the infero-lateral edge of the embryo, opposite the middle of the heart; the pelvic limbs (*pv.l.*) are round buds opposite the 20th somatome, and embracing the neck of the allantois.

So that, in this stage, all the embryological machinery is fairly at work, and rudiments of all the growing parts and members are already in existence.*

At present, the palatine or sub-ocular visceral fold (*mx.p.*) is not equal to the rudiment of the mandible (*mn.*); but the fold itself, and the oral cleft between it and the first post-oral or mandibular fold, both seem to be homologous with the parts behind this, the rudimentary mouth.

Already the mandibular fold is constricted into the shape of an hourglass; the lower part, which is very bulbous, and is uniting with its fellow of the opposite side, is the future lower jaw; the swollen part above will contain the "quadrate" or pier of the mandible, and the pterygoid bone.

The next *four* visceral folds gradually decrease in size, backwards. The first of these is the hyoid; the rest, of which the last is imperfect at present, are branchials (*hy.*, *br.*).

The hyoid fold lies directly under the rudiment of the ear-capsule; it is broad at the top, and is bounded by the first or tympano-eustachian cleft, and by the second or hyo-branchial cleft.

At present these folds are like the rudiments of floral leaves, and form very imperfect enfoldings to the *newly opened* pharynx and œsophagus.

The "thalamencephalon," or fore brain (C^1) swells down between the palatine folds, but neither the infundibulum nor pituitary body are developed as yet; at any rate, the latter is merely the apex of the involution of the mouth.

In front of the palatine fold the crescentic nasal involution (*ol.*) is seen, flanking the budding hemisphere (C^{1a}); over the palatine fold the optic involution (*e.*) is seen folding round the lens.

* Messrs. FOSTER and BALFOUR ('Elements of Embryology,' p. 142, fig. 46), have given an excellent figure of the embryo Chick at the end of the *fourth day* of incubation, which is exactly mid-way, in development, between my first and second stages of *Lacerta agilis* (Plate 37, figs. 1 and 2). These authors give *forty* "somatomes" in their figure; my first has *thirty*, and my second *fifty*. For an account of the general development of the parts the reader is referred to that work,

The ear-capsule (*au.*) is a short-necked flask, embedded in the subdorsal region of the head, opposite the hind part of the hind brain (C^3).

The organs of support are, as yet, young cells: the mother-cells of the tissues that harden into hyaline cartilage, into the fibrous webs, or into bone.

Yet how important the changes are that the embryo has already undergone it is easy to see, for everything has been marked out; and proliferating cells, in countless numbers, are ready to breed, and indeed are breeding the *filial cells* that will be transformed into the various tissues and organs.

Second Stage. Embryos of Lacerta agilis, *3 lines* ($\frac{1}{4}$ *inch*) *long.*

In this larger embryo the "somatomes" have increased from *thirty* to *fifty*, and the tail is now curled upon itself.

The allantois (*all.*) is now applying itself, in a discoid form, to the inside of the chorion, but the abdominal walls are still very imperfect, and the pericardium (*pcd.*) lies exposed on the concave ventral aspect of the embryo.

To all appearance, the head in this stage is like the last, only larger; but the fifth post-oral fold (*br.*) is now distinct, and the neck of the ear-sac is more evident.

The pituitary body is, at present, a mere fold of the oral lining; but the "pleuro-peritonal," or body cavity, is now represented by a separate cavity in each of the visceral arches, from the palatine to the fifth post-oral or the third branchial.

I shall describe these structures in the next stage, in embryos one-fourth larger than this, for in them the metamorphosis of the parts is taking place rapidly, which makes them very instructive.

Third Stage. Embryos of Lacerta agilis, *from 4 to 5 lines long.*

A good supply of embryos at this stage has enabled me to dig about the roots of my subject more than I am wont, yet in this it is necessary to exercise self-denial; if I did not, the special morphology of the skull would be lost in general embryological details.

At this stage, in which the embryo is budding and swelling with life, the differentiated groups of cells taking root downwards, and bearing fruit upwards—organs and "elements" of all sorts growing as fast as *gourds*, and yet with a perfectness of working that is as amazing as its rapidity—the eye and the mind of the close observer are kept in a continual dazzle, and it is no easy task to watch *this*, and to attend to *that*.

Here, if anywhere, I am grateful for the co-operation of such workers as BALFOUR and MARSHALL; and here, especially, does our work overlap and dove-tail.

Besides the development of the brain, cranial nerves, and organs of special sense, I must refer also to Mr. BALFOUR'S account of the development of the "pituitary body;" the "visceral clefts" and segmentation of the head; and the "body-cavities" and "myotomes" of the head ('Elasmobranchs,' plate 14, pp. 189, 206, and 211).

Here, in *Lacerta,* I have been able to verify a large number of his observations on the development of the embryo in the Sharks and Skates; and such things as are fundamental to my own special work I must introduce here.

The embryo has now well nigh completed the number of its somatomes; there are a few more than in the last stage. The "metasomatomes" have now the work of developing the vertebræ.

These embryos are often very twisted and unsymmetrical, the meso-cephalic flexure is complete, so that the mid brain (Plate 38, figs. 1, 2, C^2) bulges forwards, in a line with the axis of the embryo.

The hind brain (C^3) bulges but little, and its boundary is indefinite behind, where it runs into the "myelon;" the fore brain (C^1) is half covered by the budding, symmetrical hemispheres (C^{1a}), and these again are overlapped by the rudiments of the nasal capsules (*ol.*).

The eyeball (*e.*) has almost doubled its relative size, but its folds are still separate below; moreover, it has made its orbital "nest" neatly, by its own swelling bulk and pressure.

The "strabismus" of the eyes is nearly equal to that figured by me in the embryo Salmon, that obliquity, however, was artificial (see "On the Skull of the Salmon," Phil. Trans., 1873, Plate 1).

The ear-sac (*au.*) is now an elegant "lagena," with a short neck; the "clefts" (*cl.*) are enclosed below; the pericardial pouch is not yet covered, but the abdominal walls are fast closing in; letting out, however, the large allantois (*all.*), which is lining all the egg-wall within.

The fore limb (*pt.l.*) is becoming knuckled, so that the three main regions—arm, forearm, and hand—can be seen; the hind limb (*pv.l.*) is still a mere oval bud.

When the twisted head is tilted so as to show the base (Plate 37, fig. 7), several important things are better seen (compare that figure with fig. 1 in Plate 38).

In this figure, which is seen at once to have the same *hippopotamoid* form as the early embryo of the Pig ("Pig's Skull," Plate 28), we see that the *angles* of the huge oral involution are serially homologous with the gaping spaces behind the mouth (*cl.*, 1–4).

Also it would seem, to any unprejudiced observer, that the fold above the mouth, on which the eyeball rests, is the serial homologue of the folds behind the mouth.

That is to say, the palatine fold ("superior maxillary rudiment," "maxillo-palatine fold") appears to be the morphological equivalent of the folds next following, in which are developed the mandible, hyoid arch, and branchial arches.

I do not think that this is invalidated by the fact that the "hypoblast" ceases inside the first post-oral fold, for the hypoblast ceases at or near the anal aperture, yet this does not so affect the vertebræ as to stop the growth of (at least rudimentary) hæmal arches in the caudal region.

The first *præ-oral* visceral fold (right and left moiety of "naso-frontal process") is not

yet developed, owing to the immature state of the trabeculæ cranii, on whose "horns," or outgrowths, this twin facial fold is formed.

Beneath the hemispheres, on each side, inside the nasal fold, there is a second mass of cells, deeply pitted; this is the nasal gland, the pit is its "lumen" or future duct, and the tissue over and under it will be the vomer and septo-maxillary.

The massive palatine fold is separated by a notch from the outer nasal fold (*mx.p.*, *ol.*) and this part shelves inwards towards the base of the still membranous cranium; the thin, inner part will contain the palatine bone. The broad, concave floor of the skull is suddenly, for a large circular space, deficient, below the junction of the fore and mid brain.

Above this part (Plate 37, fig. 3, C^1) the "thalamencephalon" merely shows a rudiment of the tube, which in the adult is called the "infundibulum," but the fore brain here at its postero-inferior part, is quite closed.*

Under this part, where the floor is wide open, the *oral fold* has developed an inverted cup, with its fundus towards the brain, and its narrowing mouth looking downwards and a little backwards.

This is the rudiment of the "pituitary body" (Plate 37, figs. 3, 7, and Plate 38, fig. 1, *py.*), which, contrary to what is seen afterwards, is closed above and wide open below; the sides of the pituitary space are lipped to embrace this *unaccountable* piece of morphology—a sort of empty pocket made of the epiblast of the mouth.

Over this pocket, the axis of the embryo runs up half way to the frontal wall at right angles to the fore part of the head; this mass of tissue is the "middle trabecula" of RATHKE: a transient structure, as he pointed out. Along the back of this (Plate 37, fig. 3, *m.tr.*, *nc.*) a less transient part of the embryo runs; this is the notochord; it reaches almost to the top, becoming sinuous as it grows less and less.

On each side of the notochord, lower down, there is a mass of granular tissue ready to become cartilage, and on each side of the pituitary space, up to the nasal region, a smaller curved bar runs; the latter is the trabecula, the former the "parachordal" band.

Neither the true half section (Plate 37, fig. 3), nor the section which contains a *third* of the head (fig. 5), show these bands; the one is *outside* and the other *inside* of these symmetrical basi-cranial rudiments. I shall show their structure in the next stage. (See Plate 37, fig. 8.)

By slicing off a third of the head, vertically, I get what is shown in Plate 37, figs. 4 and 5; fig. 4 is shown from the outside as a transparent object, and fig. 5 from the inside as an opaque object.

Here Mr. BALFOUR's researches on the 'Elasmobranchs' are repeated and verified, as indeed they are on the pituitary body.

These figures show part of the pericardium and heart (*pcd.*, *h.*), the enclosing

* The true organic *punctum terminale* is close in front of the part from which the infundibulum grows out.

membrane being the inner wall of the body-cavity, or "splanchnopleure;" the "somatopleure" of this part is not developed quite so far down towards the ventral line.

The space between the pericardium and outer (*costal*) wall is only part of the general "pleuro-peritoneal" space or cavity; with this all are familiar.

But it is not generally known that the divisions of the mesoblast of the head acquire a cavity on each side. "These cavities end in front, opposite the blind anterior extremity of the alimentary canal; behind, they are continuous with the general body-cavity. I propose to call them *head-cavities*. The cavities of the two sides have no communication with each other." (BALFOUR, 'Elasmobranchs,' p. 206.)

For the sake of those who have not Mr. BALFOUR's work at hand, I will give, below, a continuation of his excellent description of these cavities.*

In both Stage 2 (Plate 37, fig. 2) and in the younger specimens of Stage 3 (Plate 37, figs. 4, 5) I succeeded in making thick slices from the side of the head, showing three cavities (*h.c.*). It will be seen that the one close to the eye (*mx.p.*, $h.c^1$.) is widest towards the mid-line of the head, and that the others are widest outside, and narrow towards the ventral line. All the post-oral cavities are distinct from each other, *right* and *left;* but the pre-oral cavity ("premandibular" of BALFOUR—I should call it the *palatine head-cavity*) opens into its fellow of the opposite side. I find the *head-cavities* in embryos of *Chelone viridis* at this same stage. I may also refer to the looped appearance of the optic nerve (fig. 4, II), and to the deep folds of the hind brain, in front of the oval, nut-like ear-sac (fig. 5, C^3, *au.*)

* "Coincidently with the formation of an outgrowth from the throat to form the first visceral cleft, the head-cavity on each side becomes divided into a section in front of the cleft and a section behind the cleft (*vide* plate 14, fig. 3, *b*, and 6, *p.p.*); and during stage H it becomes, owing to the formation of a second cleft, divided into three sections; (1) a section in front of the first or hyo-mandibular cleft; (2) a section in the hyoid arch between the hyo-mandibular cleft and the hyo-branchial or first branchial cleft; (3) a section behind the first branchial cleft.

"The section in front of the hyo-mandibular cleft stands in a peculiar relation to the two branches of the fifth nerve. The ophthalmic branch of the fifth lies close to the outer side of its anterior part, the mandibular branch close to the outer side of its posterior part. During stage I this front section of the head-cavity grows forward, and becomes divided without the intervention of a visceral cleft, into an anterior and posterior division. The anterior lies close to the eye, and in front of the commencing mouth involution, and is connected with the ophthalmic branch of the fifth nerve. The posterior part lies completely within the mandibular arch, and is closely connected with the mandibular division of the fifth nerve. As the rudiments of the visceral clefts are formed, the posterior part of the head cavity becomes divided into successive sections, there being one section for each arch. Thus the whole head-cavity becomes on each side divided into (1) a premandibular section; (2) a mandibular section; (3) a hyoid section; (4) sections in the branchial arches."—(p. 206.)

Again (p. 207) we read that "the anterior or premandibular pair of cavities are the only parts of the body-cavity within the head that unite ventrally."

When Mr. BALFOUR says that the foremost part of the cavity becomes "divided, without the intervention of a visceral cleft, with an anterior and posterior division," he evidently rejects the *mouth-angles* from the category of clefts. I do not think that the ophthalmic branch of the fifth nerve is the proper segmental nerve of the maxillo-palatine fold.

Before passing to the next stage I must mention that, according to Mr. BALFOUR, the walls of the head-cavities become composed, as the cavity closes, of columnar cells, and that these become transformed into *muscles;* and that it is "almost certain *that we must regard them as equivalent to the muscle-plates of the body, which originally contain, equally with those of the head, sections of the body-cavity.* If this determination be correct, there can be no doubt that they ought to serve as valuable guides to the number of segments which have coalesced to form the head."—(p. 208.)*

Fourth Stage. Embryos of Lacerta agilis, $\frac{1}{2}$ *inch long; head,* $\frac{1}{6}$*th of an inch.*

This is a very instructive stage, coming between the last and the fifth, in which the metamorphosis is rapidly completing itself.

I give of these a direct side view of the most mature (Plate 38, fig. 3); an under view of a more immature embryo, tilted back (Plate 37, fig. 8); an under view, tilted forward, of the riper embryo (Plate 38, fig. 4); and a dissection of the palate of this last seen in a directly lower aspect (Plate 39, fig. 1).

The mesocephalic flexure still exists; the vesicles of the brain are very bulbous; the nasal sacs (*ol.*) are distinct crescents, widely spreading under the fore face, almost repeating the form of the budding hemispheres (C^{1a}) under which they grow.

The orbit is now well formed; there is the very solid palatine fold beneath (*mx.p.*), notched off from the nasal sac (*ol.*); and over and around the eyeball (*e.*) the superorbital thickening (*s.ob.*).

The rudimentary mandibles (*mn.*) are still very arrested, leaving the gape wide open (Plate 38, figs. 3 and 4); but beneath (fig. 4, *mn.*, *hy.*), the two first post-orals are united at the ventral line: the branchials are separated by the pericardium (*pcd.*).

The clefts are still open, and especially the first, or "tympano-eustachian" (Plate 38, fig. 3, $cl.^{1}$). It is a large lozenge-shaped, gaping space, through which the cavity of the fauces and the wall of the ear-sac (*au.*) can be seen.

The mandibular operculum partly overlies this hole, and it is, externally, a continuation of the skin which is so thick behind the eye and above the angle of the mouth, where the ingrowing mandible can be seen to be hinged.

This toothless, wrinkled, bald head, bears a striking similitude to what the highest Vertebrate head degenerates into, when the life-processes are working feebly, and in a retrograde manner.

The opercular fold of the oral cleft overlaps the hinge of the mandible; that of the mandible, above, the fore part of the great tympanic cleft; and the fold on the

* The kind of work which the Embryologist does differs *in toto* from the "weaving of fine cobwebs" out of the "Philosophical Anatomist's" own consciousness, and then entitling those films of the fancy by such high-sounding words as "Exemplars" and "Archetypes."

hyoid and branchials are quite definite, and will soon coalesce with the visceral folds next behind.

The basal plate (Plate 39, fig. 1, *iv.*) is almost cartilaginous; its moieties are close together beneath the notochord (*nc.*); and in front of it they become narrow and lyriform, as the trabeculæ (*tr.*).

For they diverge round the *closed* pituitary body (*py.*); now a hollow, unrelated ball; and again they converge, and diverge, gently.

In front, the trabeculæ end in the "naso-frontal process" (*n.f.p.*), now a broad, gently emarginate fold, notched on each side to form the still open, unfinished, outer nostrils (*e.n.*).

On each side above the edge of the naso-frontal process—now at its greatest perfection as a free part—there is a rounded projection into which the cartilage of the trabeculæ is growing (Plate 38, figs. 3, 4; and Plate 39, fig. 1, *n.f.p.*).

When the nasal sacs have come close together at the mid-line, then the ends of the trabeculæ, which are now turned outwards, will form a small "cornu" on each side: even in the adult, however, this is never large, and is fused with the contiguous part of the nasal sacs (Plate 44, figs. 1 and 2, *c.tr.*).

Yet these knobs are probably the buds of an arrested, terminal, visceral arch. In the developed skull their *single splint*—the premaxillary—serves as the key-stone to the two sides of the arch of the upper face.

Before passing to the metamorphosed embryos, I may remark that several things are plain to me which were not a few years ago, and that I saw, but misunderstood, some of these details of embryology.

In my paper on the Salmon (p. 113), I mentioned the cavities inside the visceral folds; and although, in transparent objects, the solidifying cartilaginous bars were plainly shown, yet in sections of *chromic-acid preparations* I must have mistaken, in opaque objects seen by reflected light, the head cavities for spaces in the rods. (See Plate 2, fig. 10, *p.pg.*)

Also, as to the pituitary body: the vesicular projection from the postero-inferior part of the fore brain is lettered *py.* (Plate 3, figs. 3, 5, 10); it is evidently the "infundibulum." These are in the *4th stage*, viz.: embryos near or at the time of hatching.

But in young Salmon "fry" (*5th stage*), the second week after hatching, that little bag is shown with another under it, but not opening into it (ibid., Plate 4, figs. 4, 5; C^{1a}, *py.*).

Here my ignorance, at that time, of the development of the pituitary body misled me; for in the separate view of this part (fig. 5) the divisional line between the two vesicles is very distinct.

Again, as to the same structures in the Axolotl ("Skull of Urodeles," Plate 21, fig. 4), in the first stage or embryo of an *unhatched* Axolotl, one quarter of an inch long, the swelling part, lettered *py.*, is manifestly the *infundibular region* of the fore

brain, for the oral involution (see also fig. 3) is very imperfect, and the pituitary fold can scarcely be said to exist as yet.*

The mesocephalic flexure produces results not easy to be understood. RATHKE'S "middle trabecula," with the apex of the notochord lying in it, gives the appearance as if the axis of the embryo were striving to grow through the head, between the first and second vesicles of the brain (Plate 37, fig. 3, *m.tr.*; and also "Pig's Skull," Plate 28, fig. 6; and BALFOUR'S 'Elasmobranchs,' plate 14, figs. 1, 2, *m.b.*).

The mid brain is horseshoe-shaped, and the concavity is filled with stroma, in which the notochord lies; afterwards, the cartilage of the base (parachordals and trabeculæ) grow up in this direction behind the pituitary body, as the "posterior clinoid" wall.

That wall, therefore, is the permanent mark or "stigma" of the mesocephalic flexure; but the head, recovering its straightness to some extent, always brings the trabeculæ into the same line as the parachordals (post-pituitary region of base of cranium), but they were at one time at right angles with each other. (See Plate 39, fig. 3.)

That flexure, the pituitary and pineal bodies, the "visceral," as distinct and different from the *costal* arches, the fusion of segments in the head, and consequent abortive modification of certain cranial nerves, and the suppression (apparently) of several pre-oral arches;—the meaning of all these things will be revealed when we know what kind of creature an archaic *entomo-cranial* Vertebrate was.

Fifth Stage. Half-ripe Embryos of Lacerta agilis, *with head $\frac{1}{5}$ inch long.*

To harmonize the structural conditions just described with those given first in the skull of the adult Lizard would be impossible without the intervention of a stage like this, in which the metamorphosis is well nigh complete, but has left various infantile marks and features.

The outer form of the head (Plate 38, figs. 5–7), like that of a somewhat less mature embryo of the Snake ("Snake's Skull," Plate 28), suggests the idea of some "old Dragon"—some *Liassic* or even *Carboniferous* "Leviathan"—that had broken bounds from the great Fish-territory, and had become a true "Sauropsidan," developed with all the embryonic membranes, and yet stamped with the Fish's brand on every part.

This half-ripe embryo has huge eyeballs, which would seem to indicate an Ichthyopsaurian descent; yet it is scarcely conceivable that those large-eyed giants could beget and conceive the hosts of modern Lizards, many of them scarcely larger than Hornets and Dragon-flies; this is "a question to be asked" of the Evolutionist, which may possibly receive an answer some day.

When we know what exists in the perfect form of the mature Lizard, then we see

* I believe that my figures of these parts in my first paper on the Development of the Skull in the Batrachia ("Frog's Skull," Plate 3, figs. 4 and 12, and Plate 4, fig. 8) are open to the same criticism. I shall be glad, at any cost, to atone for these errors, my apology being the difficulty of the work itself, and the loneliness of the worker.

the meaning of all the exquisite drapery which enfolds this small head, with its eyeballs standing out in a manner that makes it monstrous as a Vertebrate, but which would be normal in a *Hornet* or a *Dragon-fly*.

The optic vesicle has developed more rapidly than the brain-vesicles, as may be seen by comparing this with the third, second, and first stages. Yet the eyeballs are unfinished; the dermal and epidermal outgoings show this, as also the sections that show the duplications of the vesicle itself (Plate 39, figs. 5–7).

Notwithstanding the naked-eyed condition of this *larva*, the ensocketing is most perfect—more perfect than in most embryo-Vertebrates at the same stage.

The head of the adult shows the meaning of all these initial folds and wrappings that surround this, relatively, large "apple;" each fold becomes a mass of stone-work, plate upon plate.

The mid brain (Plate 38, fig. 5, C^2) still projects backwards very much in the line of the head; it is now double; but the hemispheres are now at the top, and are much elongated (fig. 6, C^{1a}). Their lobes are separated, yet, by a considerable space from those of the mid brain, and between those parts the *pineal* elevation (*pl.*) can be seen. The hind brain (C^3) is quite overshadowed by the great optic lobes (C^2).

But this part is not so small as an outside view would suggest; in section, the hind brain is of great size, but its swelling is rather forwards than backwards (Plate 39, fig. 3, C^3).

The fore and hind regions of the base of the skull meet now at a very open angle; yet the cranial flexure is not straightened out.

But the nasal sacs are now fairly in front of the head (Plate 38, figs. 5–7; and Plate 39, figs. 3, 4); the external nostrils (*e.n.*) are now enclosed, and the internal nostrils (*i.n.*) are neat round holes, just in front of the palatine fold.

That fold, now one continuous structure externally with the fronto-nasal process, and both these with the coverings of the nose on each side, runs back to the angle of the mouth over which it coils elegantly. Its upper edge is one with the neat circle of the eyeball, a definite rim like the rim of a cup; above the eye (Plate 38, fig. 6, *s.ob.*) this fold is a wide arched band separated by a wide valley from the elevation caused by the "hemisphere." The eye-rim is even above and crenate below; the upper part is *brow* and *lid*, in one.

The edges of the upper face, seen from below (Plate 38, fig. 7), meet in front with a round outline; at the sides they only diverge gently backwards, for the mouth is becoming narrow.

The sharp outer edge will contain the maxillary, lachrymal, and jugal bones; the shelving inner fold, the palatine and transpalatine bones, met and overlapped by the pterygoid.

Behind, the base of the head widens out, the lower jaw is hinged there at each side, and between, in front of these hinges, we see the pituitary convexity.

Laterally (fig. 5) the lower jaw (*mn.*) is seen to run to the front rim of the palate;

behind the angle of the mouth the narrowed 1st cleft is seen to be heart-shaped ; a form given to it by the "epi-hyal" element (columella).

Behind these parts the 2nd cleft (*cl*^{2}.) is still seen, but this and those behind it are fast filling in.

The relations of the nasal sacs, the huge but unfinished eyeballs, and the auditory capsules, will be seen in the sections (Plates 39 and 40).

The structure of the basal parts of the "chondrocranium" will be best understood by reference to a basal dissection, and a longitudinally vertical section (Plate 39, figs. 2, 3).

From below (fig. 2), we see young but solid cartilage forming the basal plate or "investing mass" (*iv.*), and these parachordal bands, as they run forwards, become reduced to less than half their width as they pass round the pituitary body (*py.*).

Closing in upon each other in front of that body, these narrow *pro-chordal* trabeculæ soon unite for their whole length, and this common bar send upwards a cartilaginous crest, the orbito-nasal septum (Plate 39, fig. 3, *p.e.*, *s.n.*).

This partition-wall curves downwards in front, and with its upper edge the nasal roofs are fused ; at the end its base dilates where the cornua unite with the nasal walls.

On each side of the trabeculæ, outside the pituitary space, and in front of the Gasserian ganglion (V) there is a nucleus of cartilage (*b.pg.*) for articulation with a like cartilage on the pterygoid.

The notochord lies on the fusing "parachordal" bands ; it projects in front of the *post-pituitary gap*, an open space not yet enclosed off from the pituitary space. When bounded in front by the "post-clinoid" band, it becomes RATHKE's "posterior basi-cranial fontanelle."

The egg-shaped ear-sacs are now invested with cartilage ; they rest upon the co-adapted thin edge of the parachordals (*au.*, *iv.*), and are coalescing with them.

The dilated fore end of the coalesced trabeculæ shows a tendency to form a visceral outgrowth in what was the fronto-nasal process, but it is less distinct than in the Snake ; moreover, the extensive fusion of, and the long crest upon, the trabeculæ, are unlike what we see in the Ophidia (" Snake's Skull," Plate 28).

In conformity with the great size of the eyeball the optic nerve (II) is also very large ; it emerges behind a large round notch in the orbital part of the septum, in front of the diverging part of the trabeculæ, which leaves the floor open for the pituitary body.

That body (*py.*) is still only grafting itself upon the closed *infundibulum* ; their cavities are separate.

The notochord is seen ascending in front of a thick central mass, the lower part of the bulging "medulla oblongata" (C^3) ; the cavity of this part of the cerebellum (C^{3a}), of the optic lobes (C^2), and of the hemispheres (C^{1a}), are shown in the vertical section (Plate 39, fig. 3).

Between the fore and mid brain, the "pineal gland" (*pl.*) is seen, and under and in front of the hemispheres, the olfactory *crus* (I).

Under the down-turned nasal septum, this section shows the internal nostril (*i.n.*), and behind it we see the palatine thickening and the maxillary wall.

A series of delicate sections* (transversely vertical) show many other details of the structure of the skull at this stage.

The 1*st section* (Plate 39, fig. 4), is in front of the eyes, but behind the nasal roof; the septum (*s.n.*) is shown; also the nasal passages, largely occluded by the inferior turbinals and glands; and the fore part of the long hemispheres (C^{1a}).

The 2*nd section* (fig. 5) is through the front of the eye-ball, and the lowest part of the septum; the long orbito-sphenoidal cartilage (*o.s.*, seen also in fig. 3, from its inside,) is cut through its fore end.

The 3*rd section* (fig. 6) is through the wider part of the hemispheres and of the orbito-sphenoids (C^{1a}, *o.s.*); the tissue in the severed ridges, below, becomes, by direct ossification (without cartilage), the palatines and maxillaries.

This section shows the depth of the supercranial valleys, and the height of the eye-balls, equal to that of the hemispheres; here the orbital septum is thick, before the ethmoid (*p.e.*) passes into the presphenoid.

The 4*th section* (fig. 7) is through the widest part of the eyes, the hemispheres, and of the orbito-sphenoids, and the highest part of the orbital septum (C^{1a}, *o.s.*, *p.e.*); here the mandible and MECKEL's cartilage (*mn.*, *Mk.*), are also severed; at this part the trabeculæ are becoming distinct, below.

The 5*th section* (fig. 8) is between the eyes and the ears; it shows, very distinctly, the pituitary body (*py.*) as a distinct vesicle, lying under the infundibular region of the fore brain.

This section takes in the hind part of the hemispheres (C^{1a}), where they join on to the mid brain (C^2) above, and to the "thalamencephalon" (C^1) below.

Here the trabeculæ (*tr.*) are widest apart (see fig. 2); they are oval in section, being flattened, and not circular as in the Snake.

The wall of the skull is membranous below, but higher up, the stem and part of the *lower bar* of the alisphenoid (*al.s.*) are cut down obliquely, as they run into each other. Outside the trabeculæ we see the superadded cartilages of the *pterygoid region* of the mandibular "pier," namely, the ascending or "epipterygoid" rods (*e.pg.*), with a "foot" of cartilage lying against the trabecular meniscus. These will be well understood by reference to what I have described in the adult (Plate 43).

The whole of the epipterygoid (*e.pg.*) is not shown, the top was shaved off obliquely; it must be supposed to ascend one-third higher.

Below, and on each side of the mouth (*m.*), we see MECKEL's cartilage, the cerato-hyal, the cerato- and hypo-branchials, and the trachea (*Mk.*, *c.hy.*, *c.br.*, *h.br.*, *trc.*).

The 6*th section* (fig. 9) is through the brain where the optic lobes (C^2) rest upon the

* These sections, stained with "eosin," and mounted as transparent objects, were made for me by my friend, PATRICK GEDDES, Esq., and my son, Mr. W. N. PARKER.

back part of the thalamencephalon, close behind the pituitary body, in front of the "middle trabecula," and through the Gasserian ganglia (*py.* V; see also fig. 3).

Here the wide post-pituitary part of the halves of the basisphenoid (*b.s.*) are seen ascending to the ganglion on each side; the *lower bar* of the alisphenoid is above the ganglion, and the *upper bar* higher up (V, *al.s.*).

The floor of the mouth is cut away, but on the sides, part of the quadrate cartilage is seen articulating with the mandible (*q.*, *ar.*).

The rest of the sections (Plate 40, figs. 1–6) are behind the thalamencephalon, the pituitary body, and the middle trabecula. (See also Plate 39, fig. 3.)

The *7th section* (fig. 1) is through the most solid part of the mid and hind brain (C^2, C^3); it is through the foremost part of the auditory capsules (*au.*) and in front of the notochord.

The anterior "ampulla" (*a.s.c.*) is just caught, and above it the upper bar of the alisphenoid (*al.s.*), behind the end of the lower bar; here the basisphenoid (*b.s.*) is at its widest part, and the open fontanelle is between its unossified moieties.

The shaft of the quadrate (*q.*) now comes into view above the mandible (*mk.*), and in the floor of the mouth (*m.*) come the common basal piece, the cerato-hyals, the cerato- and hypo-branchials (*c.hy.*, *br.*, *h.br.*).

The *8th section* (fig. 2) shows the cavity of the mid-brain in two "horns," and the beginning of the large cavity of the hind brain is shown (C^2, C^3); the basal cartilage (*b.s.*) is closing in towards the basioccipital region; and above, the upper bar of the alisphenoid (*al.s.*) is seen over the ear-sac (*au.*).

On each side, the quadrate (*q.*) still comes into view, for it is extended back in a cochleate form to make the cavity of the ear-drum.

But in this section the parts are so many, and so important, that I have given the infero-lateral part of the *right* side in a more magnified figure (fig. 3), and part of the *left* side still more highly magnified (fig. 4).

The arch of the anterior canal (*a.s.c.*) is cut through above, and the cavity of the vestibule is shown both above and below the entrance of the auditory nerve (*vb.*, VIII). In this cavity otoconial masses are seen (*ot.*).

Opposite the "meatus internus" (VIII) we see the fenestra ovalis (*f.o.*) occupied by the stapedial base of the columella (*st.*); the "periotic" cartilage is fused with the basal plate (*b.o.*); this is seen both at its cut edge, and below.

The periotic wall below the stapedial plate does not pass round below the ear-sac to reach the basal plate; here there is another equally large "fenestra" (*f. rotunda*, *f.r.*).

Correlated with this *round window*, we see the lower part of the vestibule undergoing subdivision. The new bulb is the rudiment of the cochlea (*chl.*); it lies *below* the part from which it has budded, as we see also in the Snake ("Snake's Skull," Plate 31).

Close below the "fenestra rotunda vel cochleæ" we see the *styloid* top of the cerato-hyal bar (*st.h.*), which is not a rudiment, as in the Snake, but a perfect bar.

Here it is plainly seen that the true "epi-hyal" element ("hyo-mandibular" of the Fish) is not distinct from the stapes, as in the Batrachia, but grafted upon it. In that group the stapes chondrifies some weeks, as a rule, before the "epihyal," which is late in its appearance, and then often cuts off a proximal piece, which wedges in between the stapes and the columella. Here the "columella" is manifestly a compound organ, both *periotic* and *visceral*.

All its parts or regions can be made out, as in the Bird and Crocodile. The part grafted on the stapes (figs. 3 and 4, *st.*) is the "medio-stapedial" (*m.st.*); the down-turned hook in which it ends is the "extra-stapedial" (*e.st.*); and it has a knob turned towards the quadrate (*q.*), which is the "supra-stapedial" (*s.st.*); whilst the lower knob under the hook, turned towards the stylohyal, is the "infra-stapedial" (*i.st.*).

With an extending knowledge of the parts in various groups, we can now harmonize the whole series of modifications seen in this part of the skull from the Cartilaginous Fishes up to Man.

The 9*th* and 10*th sections* (figs. 5, 6) show the form of the auditory sac at its widest part, and its relation to the occipital arch.

The supraoccipital (*s.o.*) meets over the hind brain behind these sections; the basi-occipital (*b.o.*) is thick, hollow above, bulging below, and carries the notochord (*nc.*) on its upper surface. In fig. 5 the stylohyal (*st.h.*) is seen in section; in fig. 6 the 9th and 10th nerves (IX, X) are seen emerging between the capsule and the arch.

These figures and descriptions will make the further metamorphosis of the skull, before hatching, to be easily understood.

Sixth Stage. Skull of nearly-ripe Embryos of the Sand Lizard (Zootoca vivipara), $1\frac{1}{3}$ *inch in total length; head,* $\frac{1}{4}$ *inch long.*

The young of this species are very perfect at the time of hatching; they continue until then in the oviduct. (See BELL'S 'British Reptiles,' 1839, p. 32.) This highly-developed state of the young at birth (or hatching) is constant among the Reptiles, and also occurs in certain kinds of Birds; for instance, in the "Megapodidæ," ex. *Talegalla Lathami.*

The skull of the adult having been described, this stage wants rather to be compared with that, than to have any very detailed description.

The investing bones have all appeared, but they are thin at present, and do not perfectly cover the head, above; indeed, the parietals (Plate 41, figs. 1, 3, *p.*) are narrow, external bands, and they leave open a very large pentagonal fontanelle (*fo.*): the frontals (*f.*) have met at the frontal suture. The double chain of superorbitals on each side (*s.ob.*) are small and irregular osseous points, and give but little promise at present of their future size and strength.

But the premaxillaries, maxillaries, lachrymals, jugals, post-orbitals, supra-temporals,

and squamosals, although feeble, are all of a similar form to what is seen in the adult (Plate 41, figs. 1–3; and Plate 42, figs. 1–3).

The same may be said of those palatine splints, the vomers, and parasphenoid (fig. 2, *v.*, *pa.s.*); and in the nasal passage the septo-maxillaries (Plate 40, fig. 7, *s.mx.*) have appeared as lids to the capsule of the nasal gland (*n.g.*). The five splints of the mandible (Plate 41, fig. 3) are all present and well developed.

But the "chondrocranium" and the *endoskeletal membrane bones* are well worthy of observation, and help greatly to the understanding of the skull in the adult.

The prefrontal (*p.f.*) or ecto-ethmoid is here a mere membrane bone, although represented by an ectostosis in osseous Fishes; the same may be said of the palatines (*pa.*); the transpalatines, and pterygoids (Plate 41, figs. 1–3, *t.pa.*, *pg.*) are well developed.

All the remaining bony centres are actually grafted on to the substance of the chondrocranium, and are effecting its ossification.

Nearly all these are already present; I miss only two on each side, namely, the shaft of the alisphenoid, and the shaft of the auditory "columella."

Moreover, there are no ankylosed centres; they are all separated, even the most advanced, by wide tracts of cartilage. On the floor, the basioccipital (Plate 41, fig. 2, *b.o.*) is separated from the basisphenoid (*b.s.*) by the very large, transversely oval, "posterior basicranial fontanelle" (*p.b.c.f.*) and by cartilage outside this space right and left.

Laterally, this half-ring of bone is joined to its side plates, the exoccipitals (*e.o.*), by synchondrosis, so also they are to the upper piece, or superoccipital (Plate 41, figs. 1, 5, 6, *e.o.*, *s.o.*). This latter part is continued forwards as an angular tongue of cartilage over the roof (fig. 6, *s.o.*).

Within, on the outside, and above, the periotic triradiate suture can be seen as a wide tract of cartilage between the three bones (*pro.*, *ep.*, *op.*); and the front ray runs forwards, being continued along the edge of the side wall of the skull to the front of the orbital region (Plate 41, fig. 5).

For here the massive cranial *box* of the Selachian is exchanged for a light wickerwork *basket*; and the whole skull, in front of the ears, is a mere grating of cartilage, feebly ossified in some parts in the adult.

But not at present. *Now* the space between the eyes and ears is largely membranous, full of "fenestræ," and framed with ascending and transverse bands of cartilage.

The upper transverse band of the alisphenoid (Plate 41, fig. 5, *al.s.*) runs from the upper periotic dividing line to the postero-superior angle of the orbito-sphenoid (*o.s.*); the lower transverse band runs from the prootic to the presphenoid (*p.s.*), and behind, runs as a descending bar to finish the "foramen ovale" (V).

Behind the large optic "fenestra" (II) the main ascending bar rises; it is tied to the presphenoid by the out-turned fore part of the lower longitudinal band. In the adult, up to this point, it is ossified, but not now.

It then ascends, leaning forwards, and melts into the top bar. The orbito-sphenoids (*o.s.*) clamp the hind part of trabecular crest (presphenoid), but are developed separately. The hind part, only, is developed in the Snake, and of the alisphenoid only the bar that finishes the "foramen ovale;" whilst the presphenoidal crest, passing into the ethmoidal, does not exist, and no crest appears until we reach the nasal capsules.

Between the notched crest of the trabeculæ and the arched orbito-sphenoids there is a large oval interorbital *notch*, not "fenestra," as in the Birds.

The large orbito-sphenoids are notched in front, the lower narrow fork running furthest forwards. Where the septum rises highest below that fork, there the ethmoidal region begins; its end in front is marked off from the septum nasi by a fenestra (*p.s.*, *p.e.*, *s.n.*, *c.f.f.*).

From thence we have the rising and then descending septum nasi, which ends in front in a pair of short cornua trabeculæ, confluent with the down-turned nasal roofs.

These parts can be seen in an inner view of the dissected and divided skull (Plate 41, fig. 5); but the remainder of the skull, not yet described, is seen in the basal view (Plate 41, fig. 2).

A rather broad band of bone now separates the two basal fontanelles (*py.*, *p.b.c.f.*), but in front of the lesser space (*py.*) there is no bone; that opening, the pituitary space, is circular behind, and runs forwards to a point. This is caused by the convergence of the filiform, terete trabeculæ, which at this part are like those of a Snake, and, as in the Snake, they are ossified where they diverge most, and then join, and become ankylosed with the parasphenoid (*pa.s.*).

The ossified part (*b.s.*) runs round the front of the posterior fenestra, upwards and forwards into the "posterior clinoid wall," and outwards with a forward bend into the large padded "basipterygoid processes" (*b.pg.*). Upon the diverging hind parts of the basisphenoid the prootics (figs. 3 and 5, *pro.*) rest, with the intervention, at present, of a synchondrosial tract.

The trabecular base of the orbito-nasal septum continues rounded and thickish, up to the frontal wall (Plate 40, figs. 7, 8).

The endoskeletal part of the mandibular arch is complex, and more highly specialized in the Lizard than in any other type known to me. I have, however, already given my views of its nature and meaning in the description of the skull of the adult; there remains now the task of showing what state these parts are in in the ripe young.

The hooked and hollowed quadrate (Plate 41, figs. 1–3, *q.*) is still largely cartilaginous above and below; the "articulare" (*ar.*) leaves the condyle soft, and all MECKEL's cartilage (*Mk.*) except the thick proximal end.

The long pterygoid bone (*pg.*) reaches nearly to the corresponding vomer (*v.*); it *quite* reaches that bone (*normally*) in *Hatteria*, and in the embryos of most Birds.

The epipterygoid (*e.pg.*) rests upon a facet of cartilage on the pterygoid, a shallow cup-and-ball joint existing there; the rod itself is only ossified for two-thirds of its height (Plate 41, fig. 3, *e.pg.*), the top and bottom being cartilaginous.

The epihyal segment ("columella auris") will be described with the *sections*; the stylo-ceratohyals, hypo-hyals, basi- (vel glosso-) hyal, and the divided branchials are quite similar to what is seen in the adult (Plate 40, fig. 11; and Plate 42, fig. 5).

Of the transversely vertical sections I have only figured five. The *first* of these (Plate 40, fig. 7) is through the nasal sacs, and shows the curve of the roof in front of the inferior turbinals, and behind the nasal glands; here the septum (*s.n.*) is deepest, and is flanked below by the septo-maxillaries and filiform process of the nasal floor (*sm.x.*, *n.f.*); below these parts are the vomers (*v.*).

The *2nd section* (fig. 8) is through the eyeballs (*e*) and ethmoid (*p.e.*); the end of the upper fork, and the broad part of the lower fork, of the orbito-sphenoid (*o.s.*) are severed; so also are the superorbitals and frontals above, and the palatines (*pa.*) below.

The *3rd section* (Plate 41, fig. 7) is through the pituitary region below, and the mid brain (C^2) above; the pituitary body (*py.*), now perfect, is seen resting on the basisphenoid (*b.s.*), in the *Sella turcica;* part of the alisphenoid (*al.s.*) is seen at the top—the upper bar; and the unossified edge of the basisphenoid, where it joins the lower bar of the alisphenoid, below.

The facets of the basipterygoids (*b.pg.*), part of MECKEL's cartilage (*Mk.*), the middle part of the epipterygoid (*e.pg.*), and the ophthalmic branch of the 5th nerve (V), here come into view.

The *4th section*, Plate 40, fig. 9, is by far the most important; it is the counterpart of that described in the half-ripe embryo with the "columella" (Plate 40, figs. 2, 3, 4), and of that in the adult, showing the same element (Plate 45, fig. 6).

The section is through the mid brain or optic lobes (C^2), and cerebellum (C^3); the portio mollis or auditory nerve (VIII) is severed as it enters the vestibule (*vb*). The razor has passed exactly between the fenestra ovalis and fenestra rotunda, along the opisthotic bar that divides them. The unossified top of the quadrate (*q.*), its "otic process," is seen in section carrying the "supra-stapedial," which has coalesced with it at its edge.

Where the supra-stapedial runs into the main shaft, or medio-stapedial (*m.st.*), there the tongue-shaped extra-stapedial (*e.st.*) runs down the tympanic membrane (*m.ty.*); the infra-stapedial (*i.st.*), behind the stem, is cut through.

The stapedial base (*st.*) is seen fitting into the fenestra of the vestibule (*f.o.*); below this is the severed "stylohyal" (*s.hy.*); the arch of the anterior and the ampulla of the horizontal canals (*a.s.c.*, *h.s.c.*) are seen cut across above; and the upper bar of the alisphenoid (*al.s.*) is seen at a small distance from the capsule.

Here the basioccipital (*b.o.*) is imperfect, on account of the large basal "fontanelle;" the rudimentary cochlea buds out from the part of the capsule that lies above the basal plate.

The *5th section* (Plate 40, fig. 10) is in front of the finished arch, above and through the perfect basal plate, and remains of notochord (*b.o.*, *nc.*); a section of the hyoid

bar again appears in two places, and two of the lower branchial. Here the capsule is complete, and the horizontal canal, and the junction of the anterior with the posterior canal, are seen (*h.s.c.*, *a.s.c.*).

The interspace between the capsule and the basal plate admits of the exit of the 9th and 10th nerves (IX, X); the 12th is behind, and the 7th and 8th in front, of this section; these two last sections show how little the ectosteal plates have affected the chondrocranium as yet.

This brings me back again to the description of the adult skull, with which I began this paper; it is seen here how perfect the metamorphosis has been before the birth of the embryo.

Conclusion.

One of the first things suggested to the mind is the large amount of detail that has to be gone through in working out exhaustively the skull of this little Lizard: one of the smallest of the Vertebrates.

In former days, when a mere gradational study of anatomy satisfied men's minds, then both the figures and the descriptions of a Lizard's skull cost but little trouble. Given, a dry museum skull, an artist's figure, and a Comparative Anatomist to describe it, and the thing was done in an hour.

In those days *membrane*, and even *cartilage*, were not reckoned among the skeletal tissues; and if the centres of ossification in some "fœtus" were seen and counted, then, indeed, a great stroke had been made in Osteology.

In this way, both as to the skull and the skeleton generally, the skeleton of the Vertebrata was easily mastered.

The Embryologists have altered all this, and now it is no easy thing to describe either the skull, in part, or the skeleton as a whole.

Half-a-century ago, to those who knew nothing of development, nothing seemed more self-evident than that the skull of a Vertebrated animal was composed of three or four vertebræ, homologous with those of the spine.

But a new generation arose, who knew not the first framers of Vertebral theories of the skull; and the leader of this new race showed that we must watch the growth of an organism if we would understand the meaning of the parts in the adult.

An adult—any adult—organism means a creature that has undergone a series of metamorphoses; this is equally true of the *Monad* or the *Man*.

With the burden of this truth laid upon him—no easy yoke—the writer has worked at this and at other types; those who know most of these subjects are the best fitted to judge as to whether such labour has been in vain.

Of necessity, the *morphology* of the Vertebrated skeleton, if its foundation be broadly laid in *embryology*, must be a branch of biological science bristling with sharp, steely, technical terms.

I have felt this strongly in my own restricted field of work; but, as much as in me lies, I have endeavoured that all my new terms should bear a filial relationship to the old familiar terms of human anatomy.

In watching the metamorphosis of the skull, not forgetting the rest of the organs, in type after type of the Vertebrata, I am sustained and cheered by the hope, and even the prospect, of discoveries in this field, such as shall "make all things new" in the science.

My fellow-workers, the Embryologists, both those who work at the Vertebrata and those who choose the Invertebrata, are continually shedding the most welcome light upon my task: the present paper will show how much I value their work, and whether or no I have profited by it.

It requires no little self-restraint to keep on digging about these special roots of one's own selection, and not to go abroad over the whole field of Embryology. I trust, however, that this has been done in this and other papers of mine.

About half the work of a Lizard's growth has been done when we come to the *first* stage; and yet these embryos were only the *fifth of an inch long*, measured along their greatest curve.

And yet, here, at once, we are confronted with all that is distinctively *Vertebrate*; all the knot and difficulty of harmonising these segmented forms with the segmented forms of the "Arthropods" is presented to us at once in the *mere outline* of a Vertebrate.

Thus a large chapter in Embryology, proper, has to be read off before my work is begun; I merely run along one of the lines marked out by my valued co-workers.

But in starting from this point I am supposed to know what has been done up to that time, and in ascending the scale of stages in the growth of this *selected region* the metamorphosis of the whole organism has to be kept in mind, for nothing stands by itself, or is unrelated.

This is true of this special type; but it is also to be considered that anything in the skeleton itself, as it develops and becomes metamorphosed, has to be thought of in comparison with its own proper "homologue" in all the Vertebrates below, as well as in all those above it. Thus, a single "exoskeletal" bony plate, such as the *frontal bone*, has to be considered in its uprise among the *old Ganoid Fishes*, and traced up to far beyond the Lizard, until its last and most perfect development is seen in our own species; this, assuredly, is the easiest thing in the whole business, and yet it involves no little labour and patience.

I must remind the reader of the new light we are now getting upon the formation of the visceral arches, and their relation to the muscular segments and to the segmental nerves. The extension of the "pleuro-peritoneal cavity" into the head, and its subdivision and subsequent extinction there, and the formation of the pituitary body;—for all these matters I may refer to the descriptions here given, but still more to Mr. BALFOUR'S works.

The comparison of the Lizard's skull with that of the Snake, given in my last paper (Phil. Trans., 1878, Part II.), is of great interest.

In some respects they are much alike, and the development is the same, essentially, in both; but there are many delicate specializations in the Lizard's skull that are not to be found in that of the Serpent. Thus the nasal capsule is more labyrinthic; the auditory apparatus more developed, having a tympanic cavity, and a separate stapedial muscle; for the senses of this creature are more refined, and it belongs to a higher type.

The cranial walls have a remarkable, and yet very delicate, development; the "chondrocranium" is much more developed than that of a Snake, but it is for the most part a mere piece of basket-work.

The "exoskeletal" bones, outside this basket-work, and outside the labyrinths of the ears and nose, are very numerous; and their interpretation can only be made by one who is familiar with the outworks of the skull in Amphibia and Fishes.

As this is but my *second* paper on the Reptilian skull, and as others are in hand, I shall defer further comparisons until more work is wrought, and brought out.

List of Abbreviations.

The Roman figures indicate the nerves or the nerve foramina.

ag.	Angular.
all.	Allantois.
al.s.	Alisphenoid.
ar.	Articular.
ar.c.	Articular cavity.
a.s.c.	Anterior semicircular canal.
au.	Auditory organ.
b.hy.	Basihyal.
b.o.	Basioccipital.
b.pg.	Basipterygoid.
br.	Branchial arch.
b.s.	Basisphenoid.
C^1.	Fore brain.
C^{1a}.	Cerebral hemispheres.
C^2.	Mid brain.
C^3.	Hind brain.
C^{3a}.	Cerebellum.
c.br.	Cerato-branchial.
c.f.f.	Cranio-facial fenestra.
chl.	Cochlea.
c.hy.	Cerato-hyal.
cl.	Visceral cleft.
co.	Columella.
c.op.	Opisthotic cartilage.
cr.	Coronoid.
c.tr.	Cornua trabeculæ.
c.ty.	Tympanic cavity.
d.	Dentary.
e.	Eye.
e.n.	External nostril.
e.o.	Ex-occipital.
ep.	Epiotic.
e.pa.	Ethmo-palatine.
e.pg.	Epipterygoid.
e.st.	Extra-stapedial.
eu.	Eustachian canal.
f.	Frontal.
f.b.pg.	Facet for basi-pterygoid.
f.m.	Foramen magnum.
fo.	Fontanelle.
f.o.	Fenestra ovalis.
f.pg.	Facet for pterygoid.
f.r.	Fenestra rotunda.
h.	Heart.

h.br. Hypo-branchial.
h.c. Head cavity.
h.hy. Hypo-hyal.
h.s.c. Horizontal semicircular canal.
hy. Hyoid arch.
i.c. Internal carotid artery.
i.n. Internal nostril.
inf. Infundibulum.
i.ob. Infra-orbital.
i.o.n. Interorbital notch.
i.st. Infra-stapedial.
i.tb. Inferior turbinal.
iv. Investing mass.
j. Jugal.
l. Lachrymal.
l.c. Lachrymal canal.
m. Mouth.
Mk. MECKEL'S cartilage.
mn. Mandible.
m.p. Muscle-plates.
m.st. Medio-stapedial.
m.tr. Middle trabecula.
m.ty. Membrana tympani.
mx. Maxilla.
mx.p. Maxillo-palatine.
n. Nasal.
nc. Notochord.
n.f. Nasal floor.
n.f.p. Naso-frontal process.
n.g. Nasal gland.
n.p. Nasal passage.
oc.c. Occipital condyle.
ol. Olfactory sac.
ol.c. Olfactory cartilage.
ol.f. Olfactory fenestra.
op. Opisthotic.
o.s. Orbito-sphenoid.
ot. Otoconia.
p. Parietal.
pa. Palatine.
p.all. Pedical of allantois.
pa.s. Parasphenoid.
p.b.c.f. Posterior basicranial fontanelle.
pcd. Pericardium.
p.e. Perpendicular ethmoid.
p.f. Prefrontal.
pg. Pterygoid.
ph. Pharynx.
pl. Pineal gland.
p.p. Pars plana.
pro. Prootic.
p.s. Pre-sphenoid.
p.s.c. Posterior semicircular canal.
pt.l. Pectoral limb.
pt.o. Post-orbital.
pv.l. Pelvic limb.
px. Pre-maxilla.
py. Pituitary body.
q. Quadrate.
s.ag. Sur-angular.
s.mx. Septo-maxillary.
s.n. Septum-nasi.
s.o. Supraoccipital.
s.ob. Superorbital.
sp. Splenial.
sq. Squamosal.
s.st. Supra-stapedial.
s.t^{1}. First supra-temporal.
s.t^{2}. Second supra-temporal.
st. Stapes.
st.h. Stylo-hyal.
st.m. Stapedius muscle.
t.pa. Transpalatine.
tr. Trabeculæ.
trc. Trachea.
u.l. Upper labial.
v. Vomer.
vb. Vestibule.

N.B.—The palatal membrane bones and the prefrontals were coloured in the last paper "On the Snake's Skull;" they are not in this.

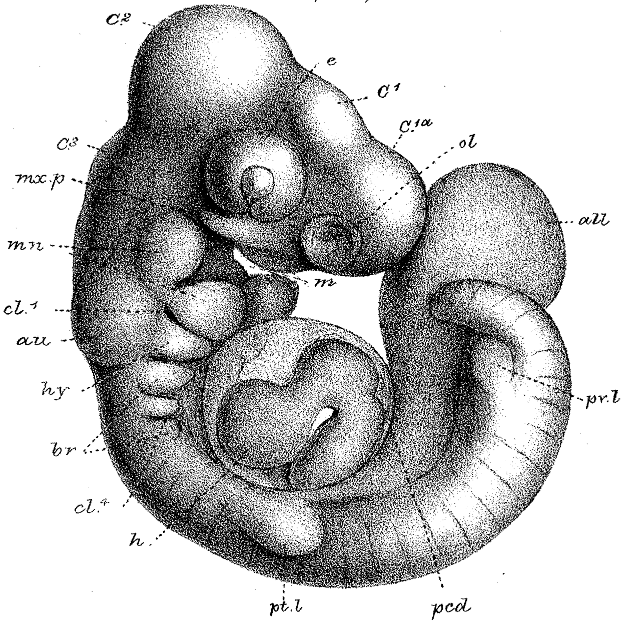
Explanation of Plates.

Plate.	Fig.	Stage.		Number of diameters magnified.
37	1	1st	Embryo of *Lacerta agilis*, $2\frac{1}{2}$ lines in total length	26
,,	2	2nd	Embryo of *Lacerta agilis*, 3 lines ($\frac{1}{4}$ inch) long	26
,,	3	3rd	Embryo of *Lacerta agilis*, 4 lines ($\frac{1}{3}$ inch) long. A vertical section of head	15
,,	4	,,	Head in vertical section, *less than half*, seen as a transparent object from the outside	26
,,	5	,,	The same, seen as an opaque object from within	26
,,	6	,,	Head, seen from above	20
,,	7	4th	Head of an embryo of *Lacerta agilis*, whose total length was 5 lines. Oblique inferior view	15
,,	8	,,	Head of another rather larger embryo, with inferior arches removed. Lower view	14
38	1, 2	,,	Right and left views of the entire embryo whose head is drawn in Plate 37, fig. 7	20
,,	3	5th	Side view of the head of an embryo of *Lacerta agilis*, whose head was 2 lines ($\frac{1}{6}$ inch) long	10
,,	4	,,	The same head. Lower view	10
,,	5	6th	Head of embryo of *Lacerta agilis*, $\frac{1}{5}$ inch long from snout to occiput. Side view	10
,,	6	,,	Upper view of same	10
,,	7	,,	Lower view of same	10
39	1	5th	Same as Plate 38, figs. 3 and 4. Lower view, with palate dissected	12
,,	2	6th	Same as Plate 38, figs. 5–7. Lower view, palate dissected longitudinally	12
,,	3	,,	Same head, in vertical section	12
,,	4	,,	Same-sized embryo. Transversely vertical section through nasal sacs. (1st section)	18
,,	5	,,	The same, through fore part of eyeball. (2nd section)	18
,,	6	,,	The same, a little further back. (3rd section)	18

Plate.	Fig.	Stage.		Number of diameters magnified.
39	7	6th	The same, through widest part of eyeballs. (4th section)	18
,,	8	,,	The same, through back part of eyeballs. (5th section)	18
,,	9	,,	The same, between eye and ear. (6th section) .	18
40	1	,,	The same, through fore part of ear-sac. (7th section)	15
,,	2	,,	The same, through middle of ear-sac. (8th section)	15
,,	3	,,	Part of same object. Right side	45
,,	4	,,	Part of same object. Left side	90
,,	5	,,	Same head, near back of ear-sac. (9th section) . .	15
,,	6	,,	The same, at back of ear-sac. (10th section) . .	15
,,	7	7th	Head of nearly ripe embryo of *Zootoca vivipara*, $1\frac{1}{3}$ inch long; head $\frac{1}{4}$ inch, or 3 lines in length. Transversely vertical section through nasal sac. (1st section)	20
,,	8	,,	The same, through fore part of eyeballs. (2nd section)	20
,,	9	,,	The same, through middle of ear-sac. (4th section)	12
,,	10	,,	The same, through hinder third of ear-sac. (5th section)	20
,,	11	,,	Same stage of embryo: hyo-branchial arches . .	14
41	1	,,	Nearly ripe embryo of *Zootoca vivipara*: skull. Upper view	14
,,	2	,,	The same. Lower view	14
,,	3	,,	The same. Side view	14
,,	4	,,	Longitudinally vertical section of head of same . .	14
,,	5	,,	The same object, with brain removed	14
,,	6	,,	Part of the same skull as figs. 1–3. Upper view .	14
,,	7	,,	Transversely vertical section through the head of the same, between eyes and ears. (3rd section)	20
42	1	8th	*Lacerta agilis*, adult male: skull. Upper view .	5
,,	2	,,	The same, seen from below	5

Plate.	Fig.	Stage.		Number of diameters magnified.
42	3	8th	The same. Side view	5
,,	4	,,	The same. End view	5
,,	5	,,	The same: hyo-branchial arches	5
43	1	,,	*Lacerta agilis,* adult female. Longitudinally vertical section of head	5
,,	2	,,	The same, with brain removed	5
,,	3	,,	The same: outer part of ear-drum	12
,,	4	,,	The same, with half the occipital arch attached .	12
,,	5	,,	The same: nasal gland and capsules	12
,,	6	,,	The same: "columella" detached	14
,,	7	,,	*Lacerta viridis,* adult female: endocranium. Upper view	4
,,	8	,,	Part of same. Side view	4
44	1–10	,,	*Zootoca vivipara,* adult female: a series of transversely vertical sections of decalcified skull, from snout to orbit	15
45	1–6	,,	The same as in Plate 44: the rest of the sections from fore part of eyeball to hind part of ear-capsule	15

I (× 26)



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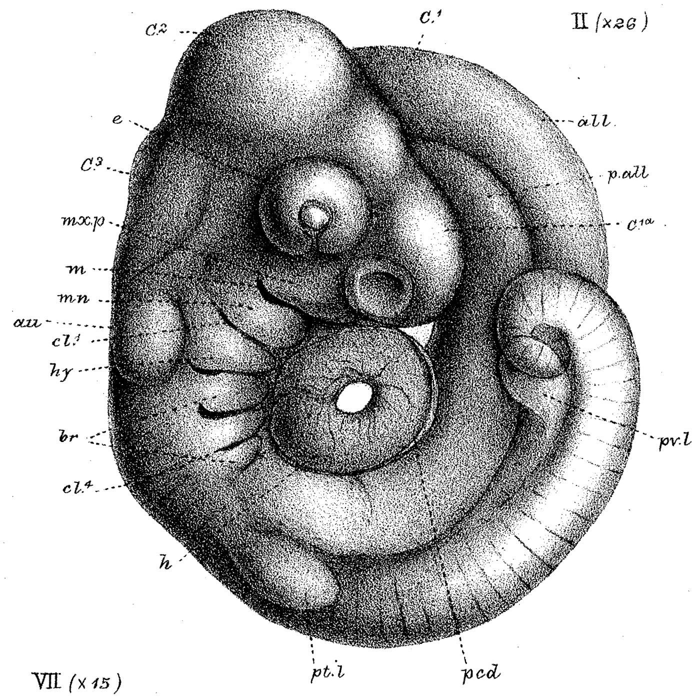

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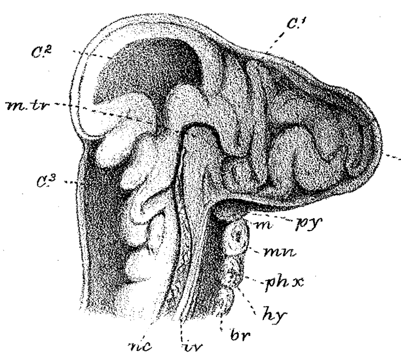

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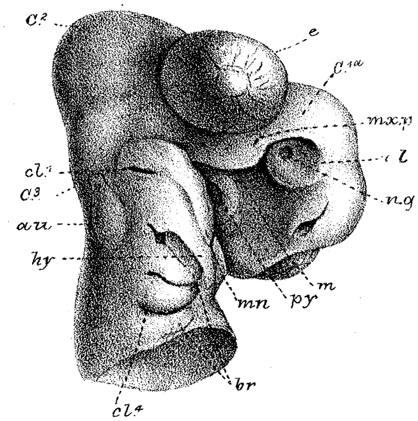

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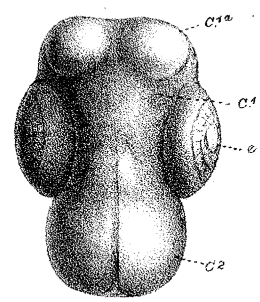

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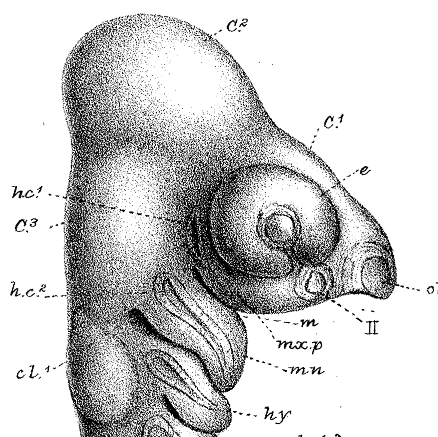

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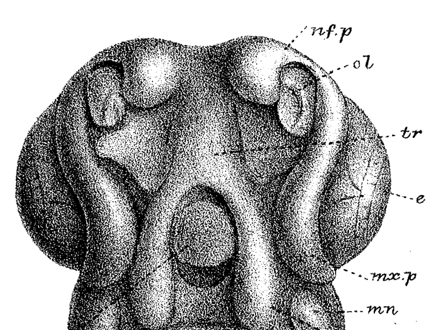

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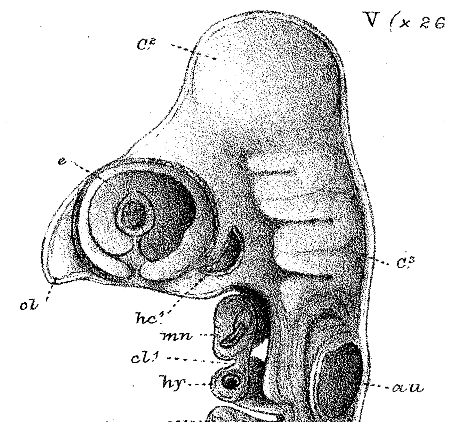

W. K. P. del. ad nat.
G. West Junr. lith.

West, Newman & Co imp.

Lacerta agilis

Figs. I, 1st Stage. II, 2nd Stage. III–VII, 3rd Stage. VIII, 4th Stage.

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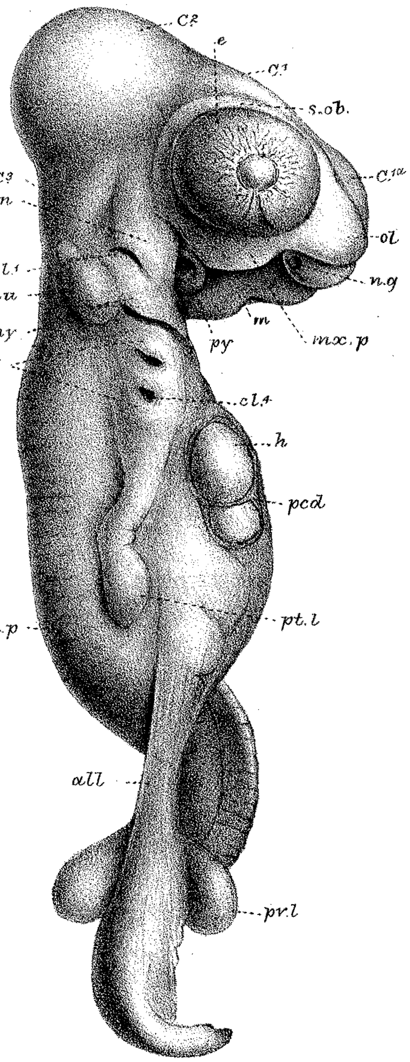

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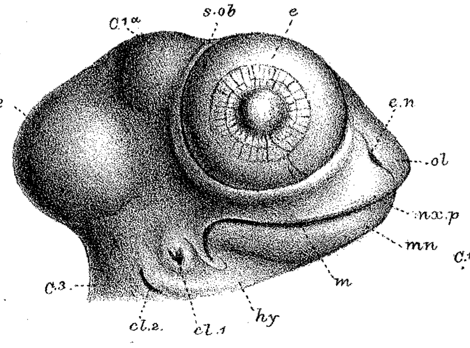

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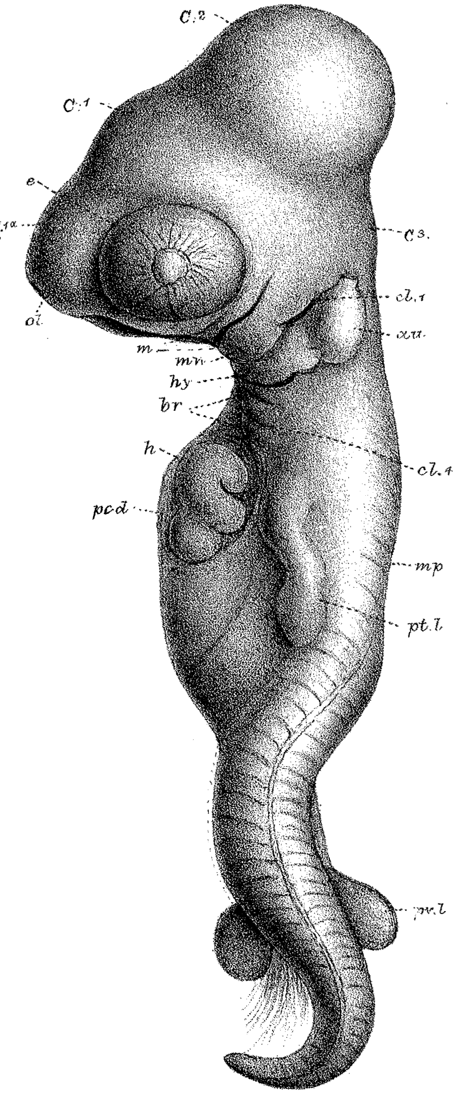

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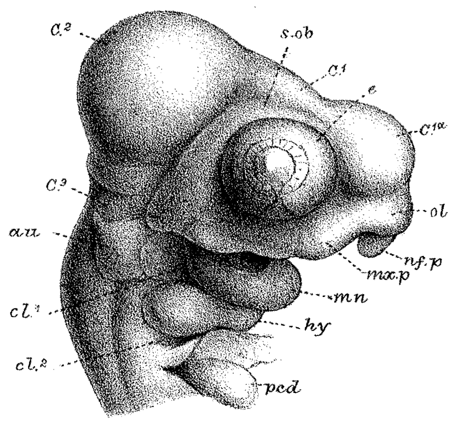

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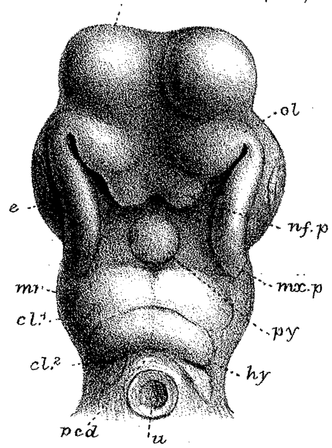

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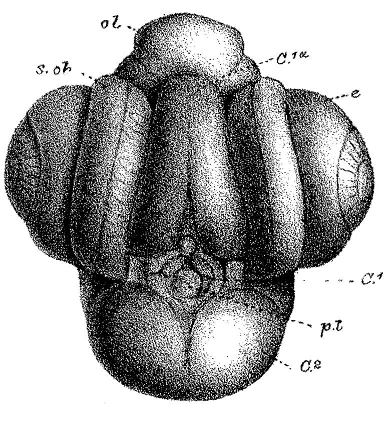

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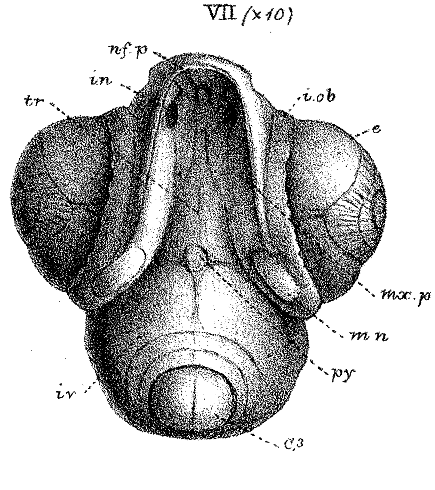
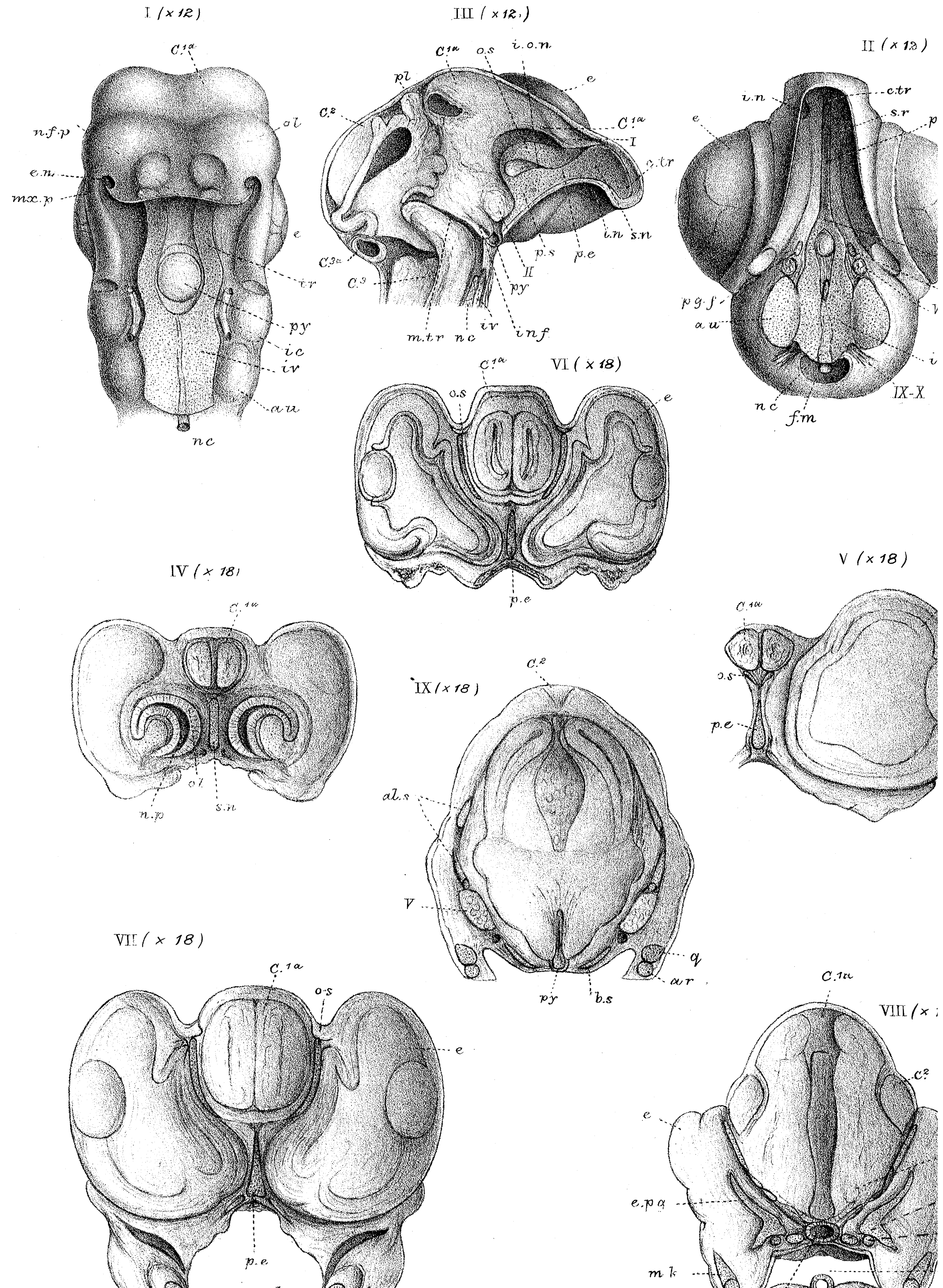


W.K.P. del. ad nat.
G. West Jun.r lith.

Lacerta agilis.

Figs. I, II, 3rd Stage. III, IV, 4th Stage. V–VII, 5th Stage.

West, Newman & Co. imp.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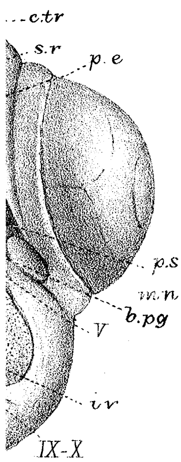

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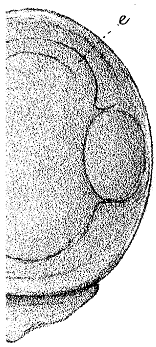

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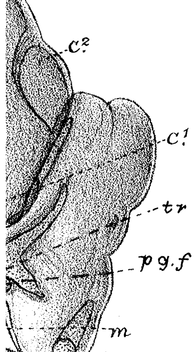
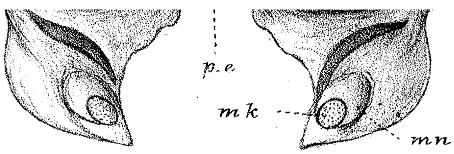
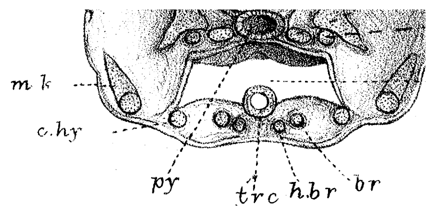


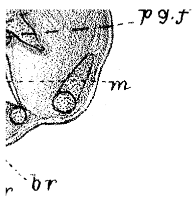




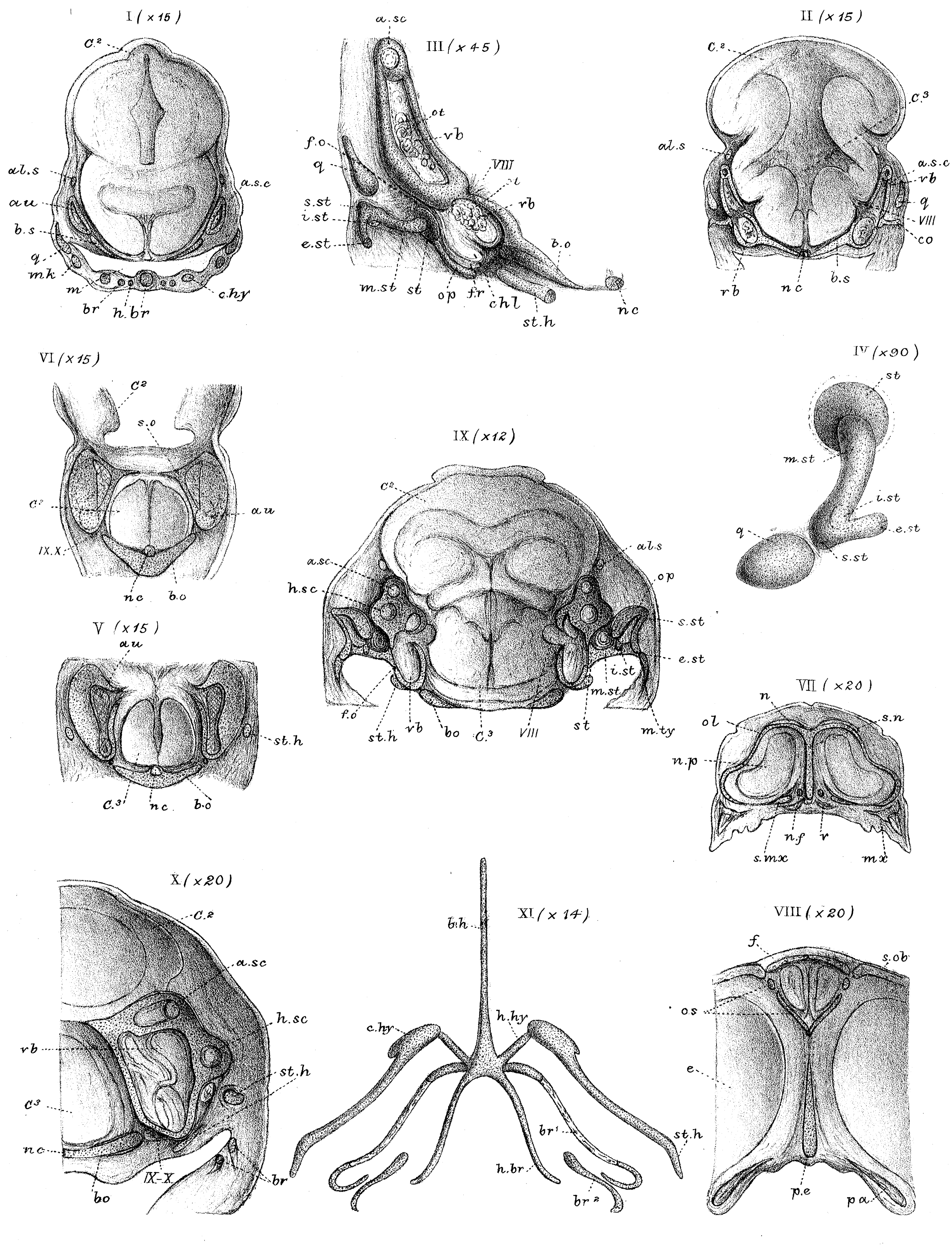
W.K.P. del. ad nat.
G. West Junr. lith.

West

Lacerta agilis.
Fig. I. 4th. *stage*; II–IX 5th. *stage*.



West, Newman & Co. imp.

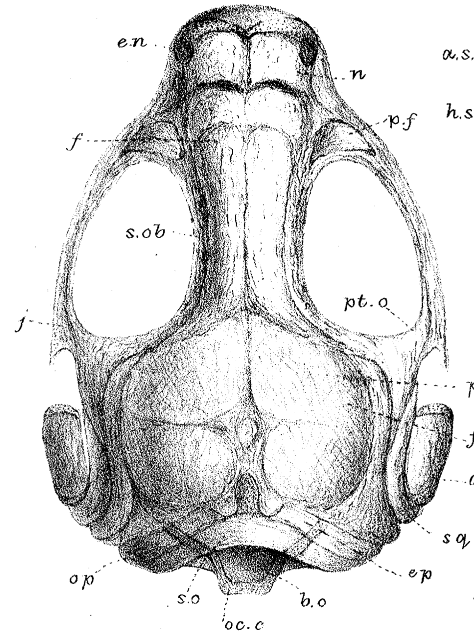


W. K. P. del. ad nat.
G. West Jun.r lith.

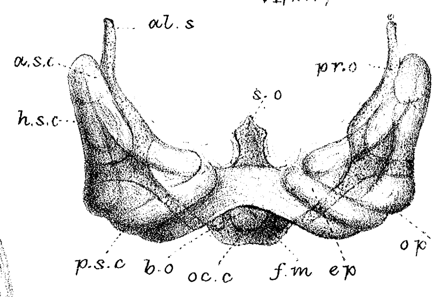
Lacerta agilis. Figs. I–VI 5th Stage.
Zootoca vivipara. " VI–X 6th. "

West, Newman & Co. imp.

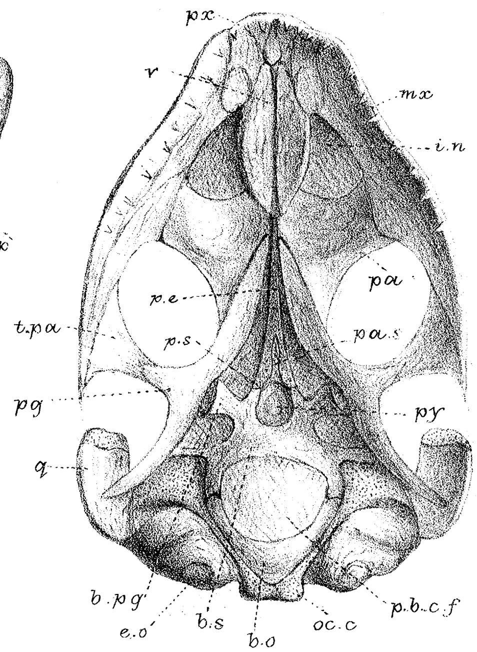
I (x14)



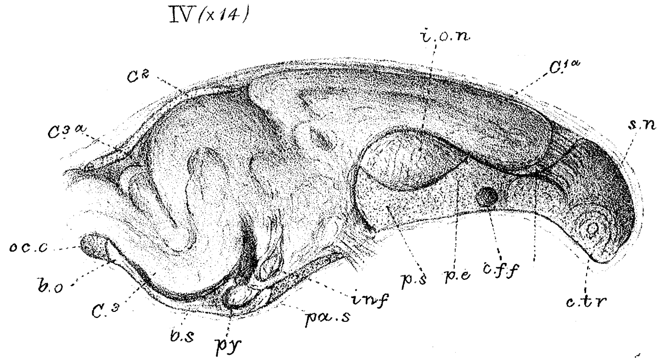
VI (x14)



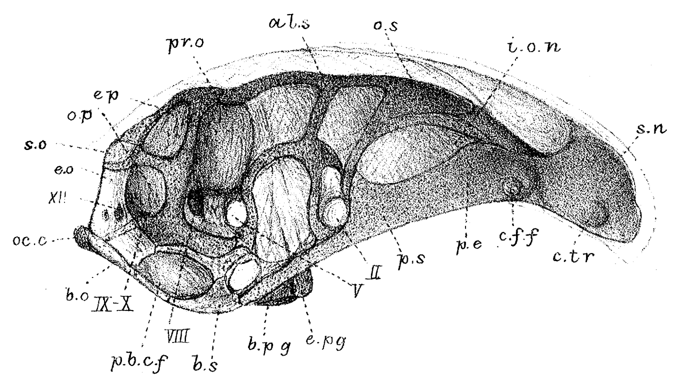
II (x14)



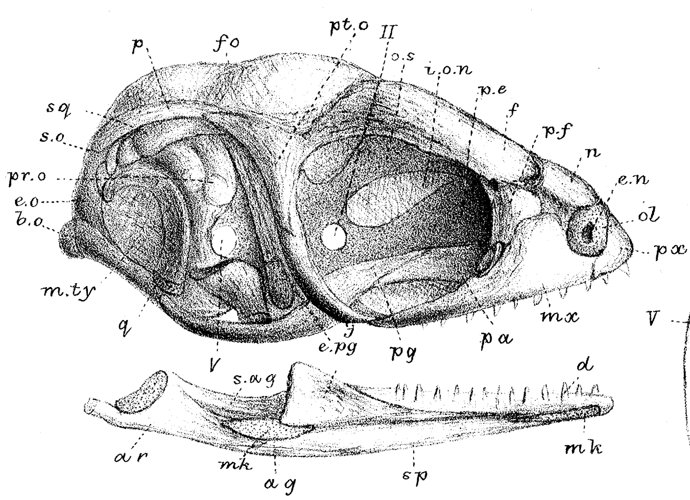
IV (x14)



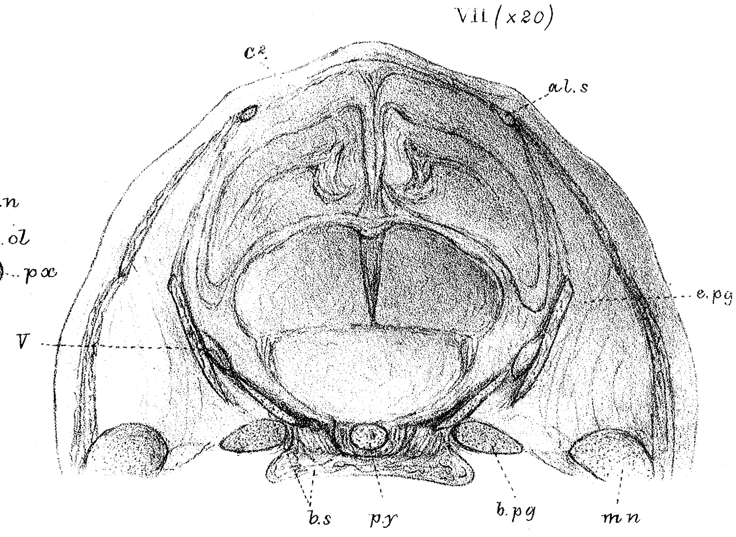
V (x14)



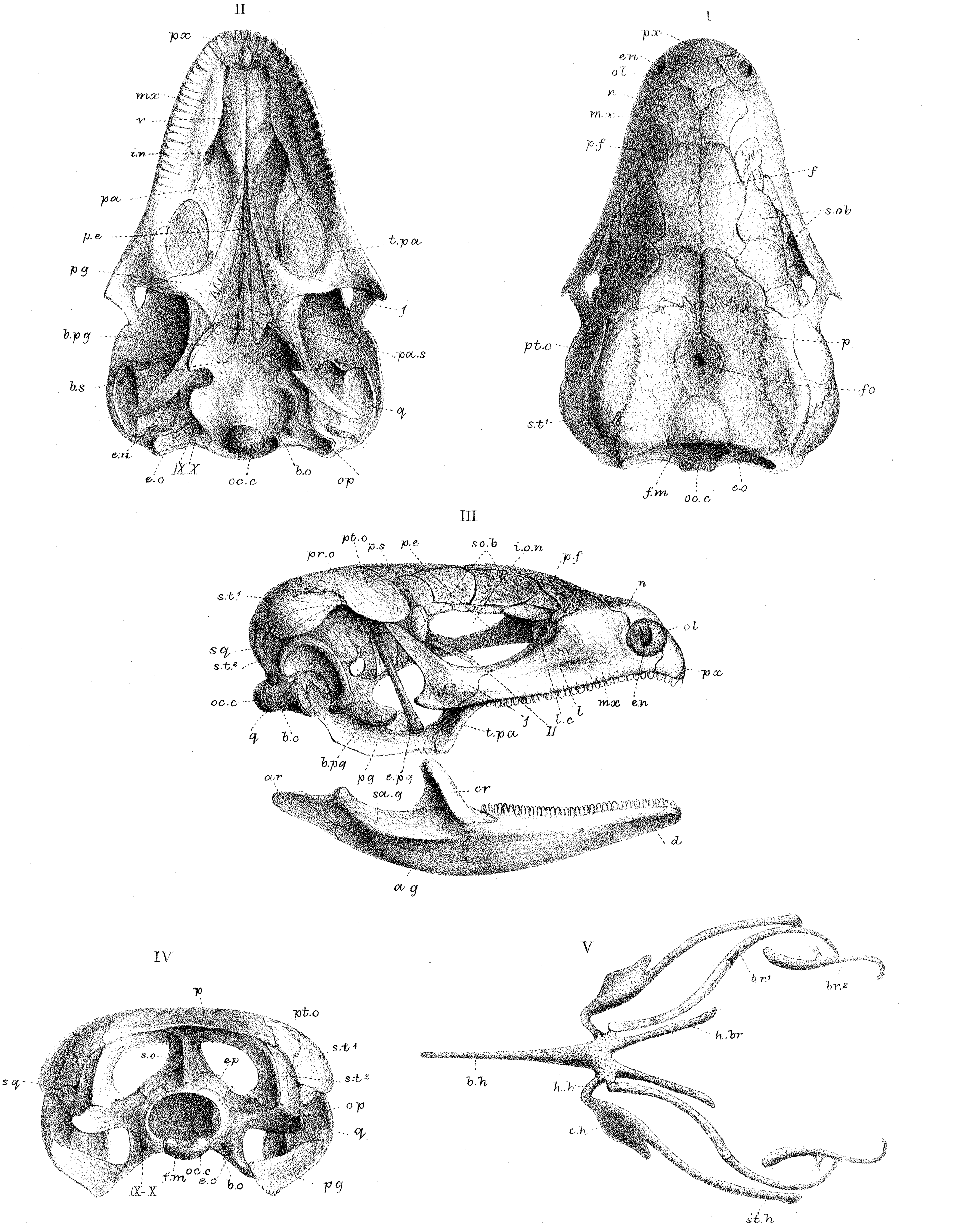
III (x14)



VII (x20)



Zootoca vivipara
6th stage



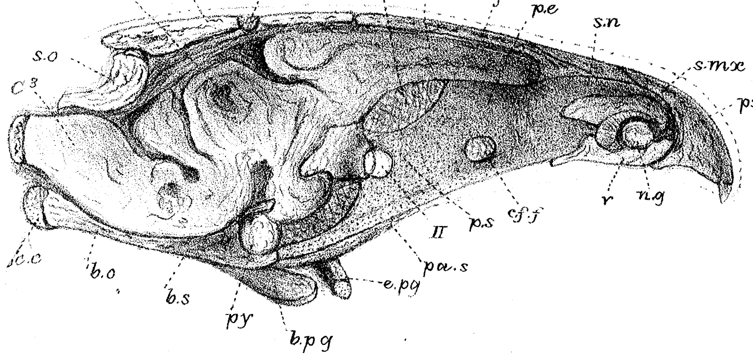
W.K.P. del. ad nat.
G. West Junr. lith.

West, Newman & Co.

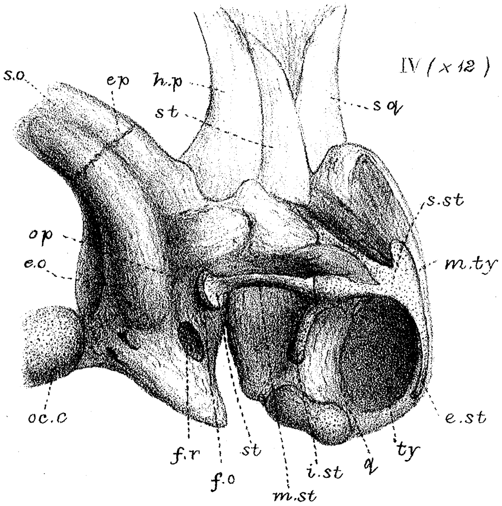
Lacerta agilis. (adult.)

(x 5)

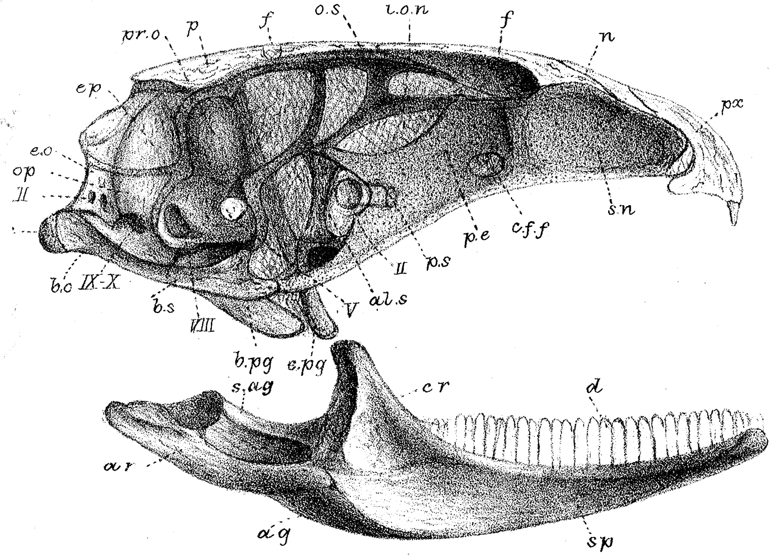
I (× 5)



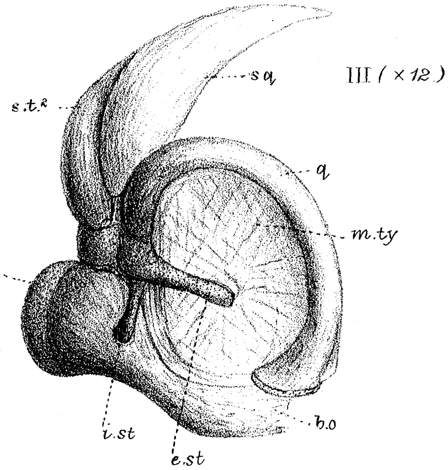
IV (× 12)



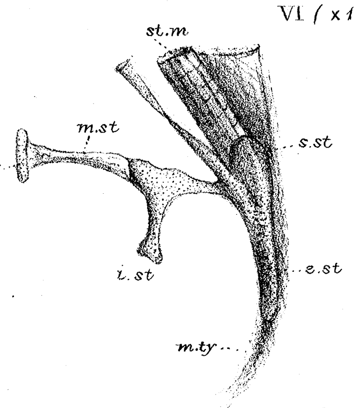
II (× 5)



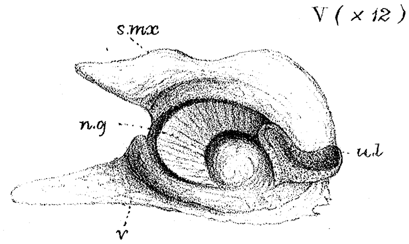
III (× 12)



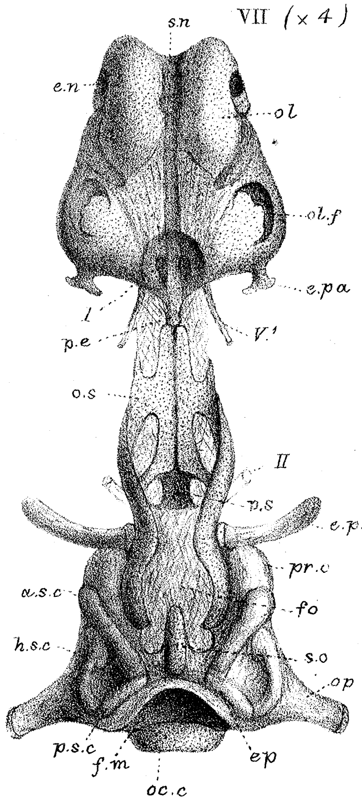
VI (× 14)



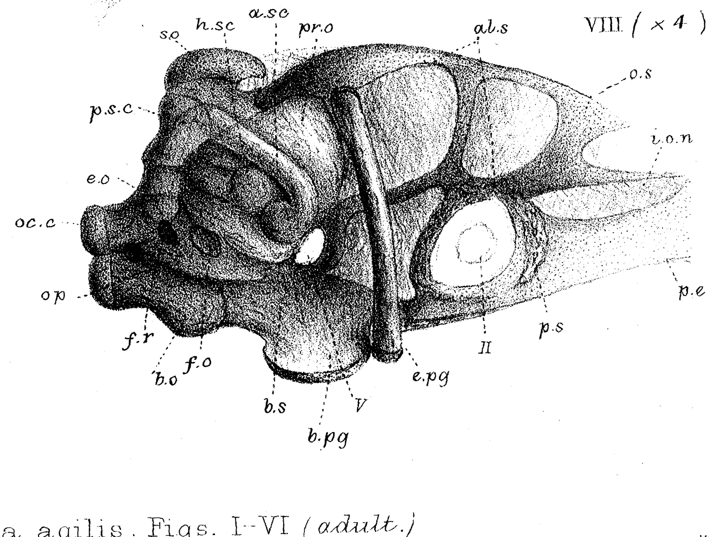
V (× 12)



VII (× 4)



VIII (× 4)

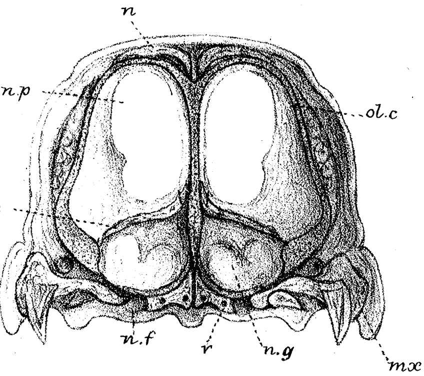


Lacerta agilis. Figs. I–VI (adult.)
„ viridis „ VII, VIII („)

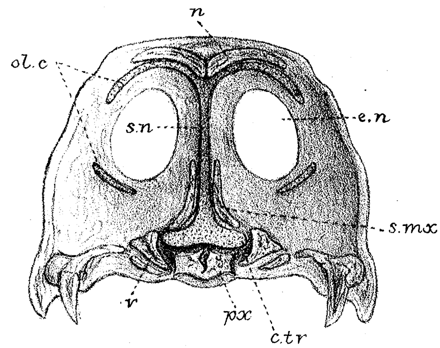
W.K.P. del. ad nat.
G. Westelan lith.

West, Newman & Co.

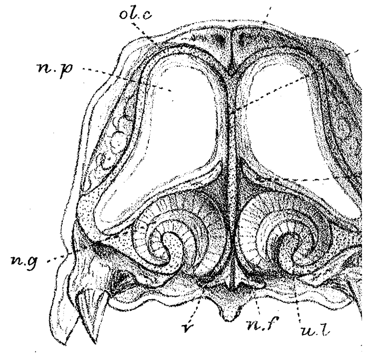
III



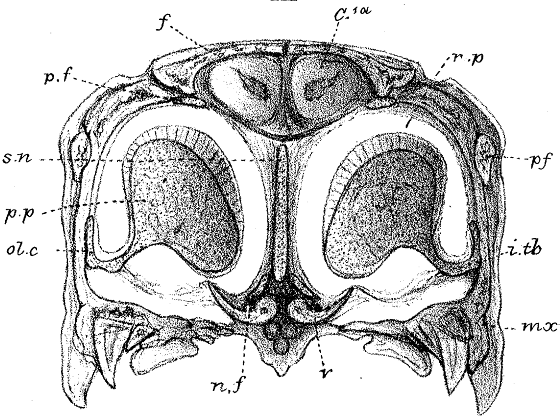
II



IV



VIII



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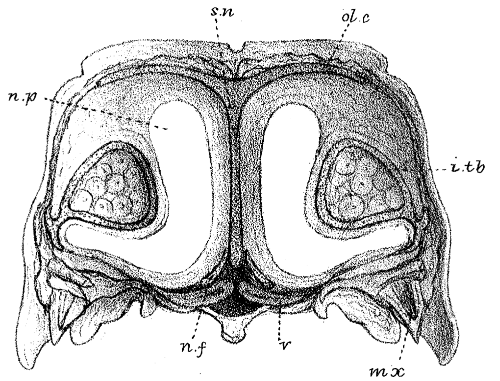

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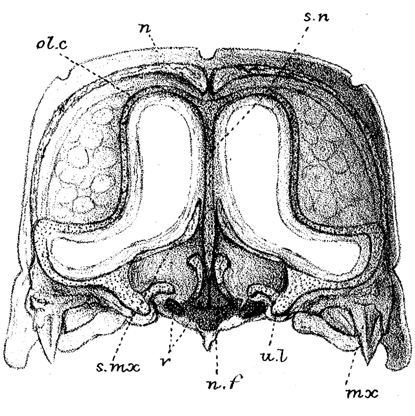

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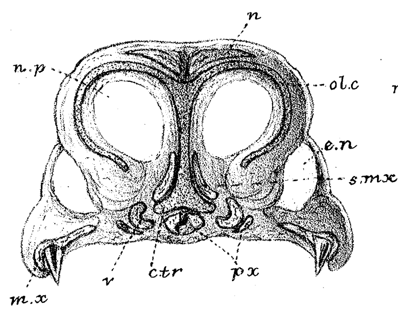
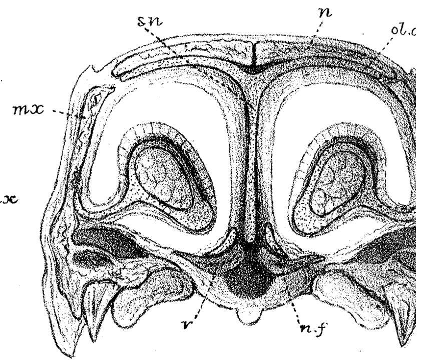


VII



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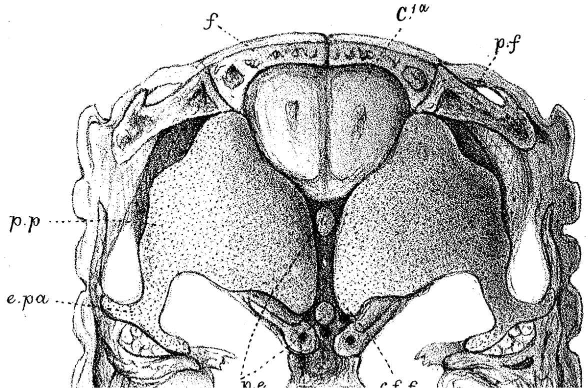

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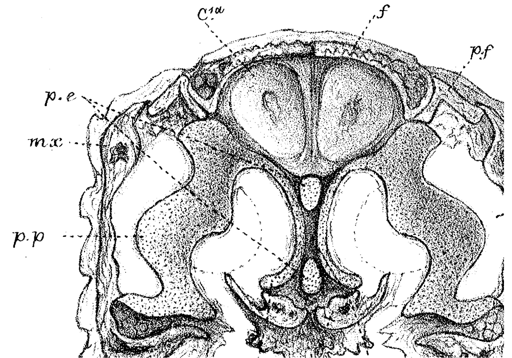

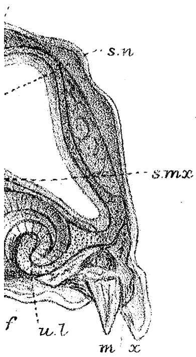
s.n
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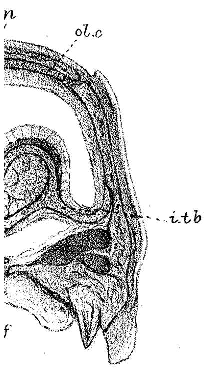
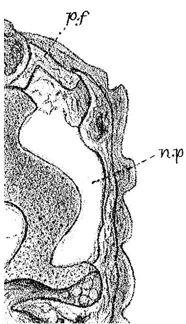
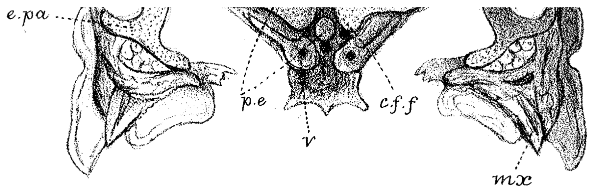
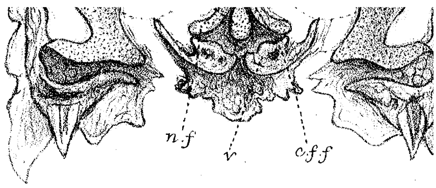

n
ol.c
i.tb
f


p.f
n.p

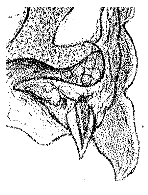




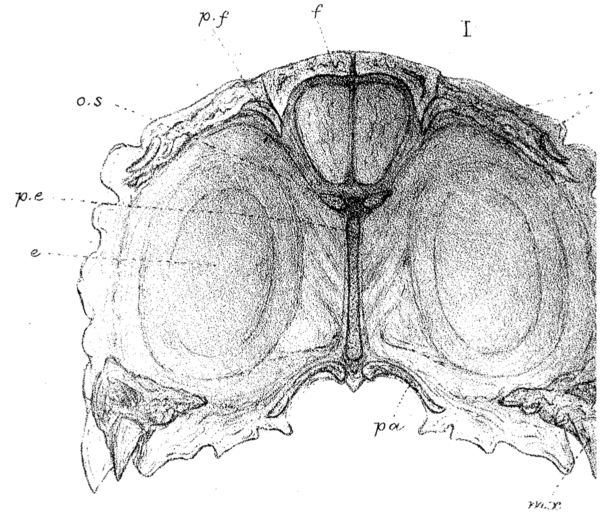
W. K. P. del. ad nat.
G. West Jun.r lith.

West, Newman

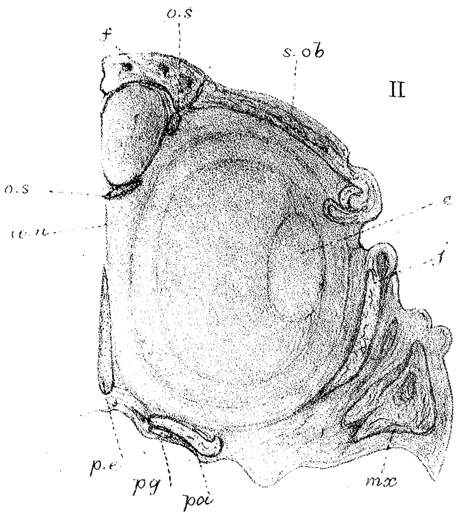
Zootoca vivipara (*adult.*)
(× 15)



West, Newman & Co. imp.



I



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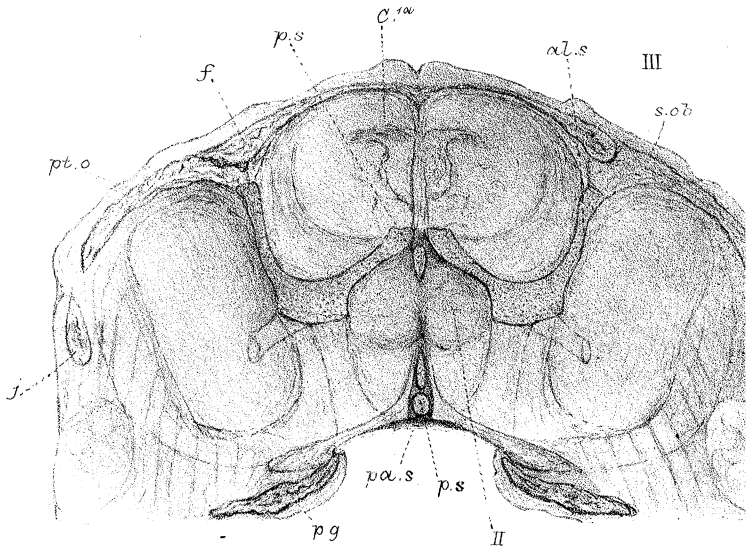

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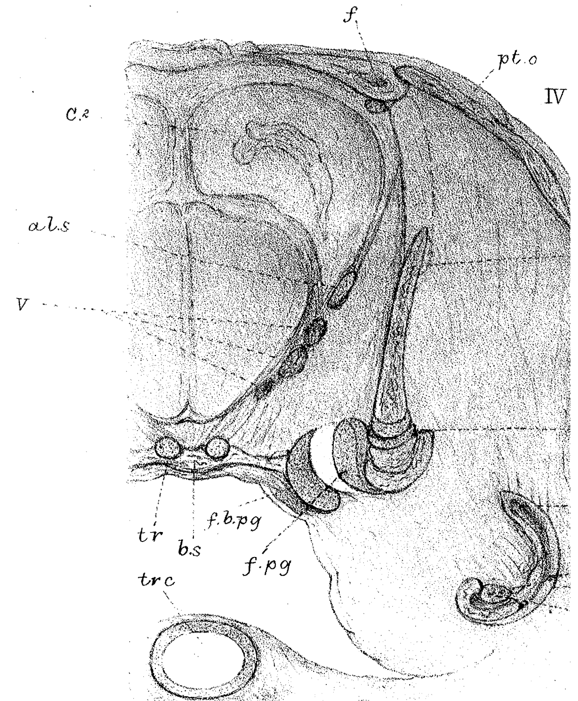
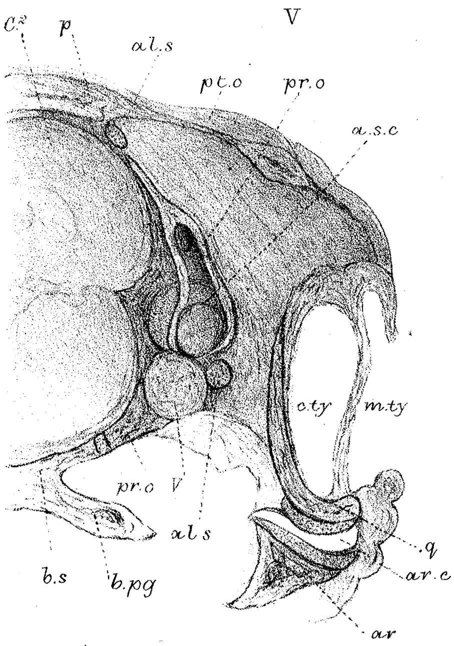


IV



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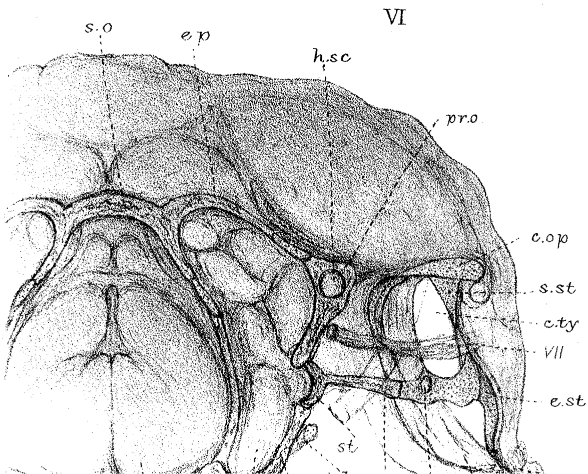
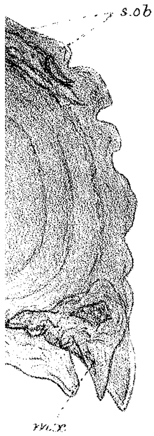
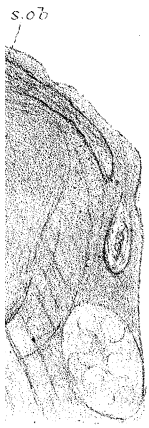
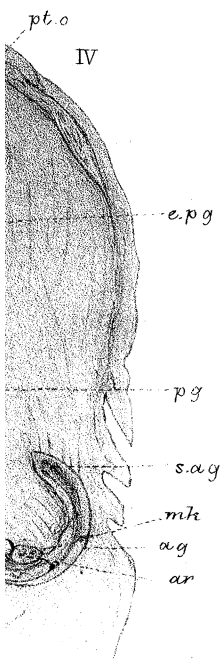


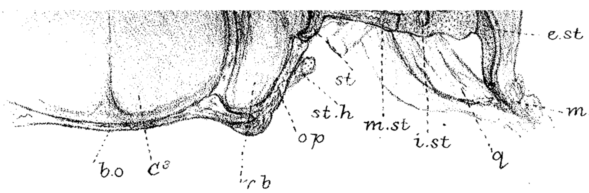
VI

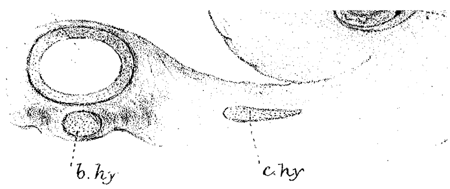


II









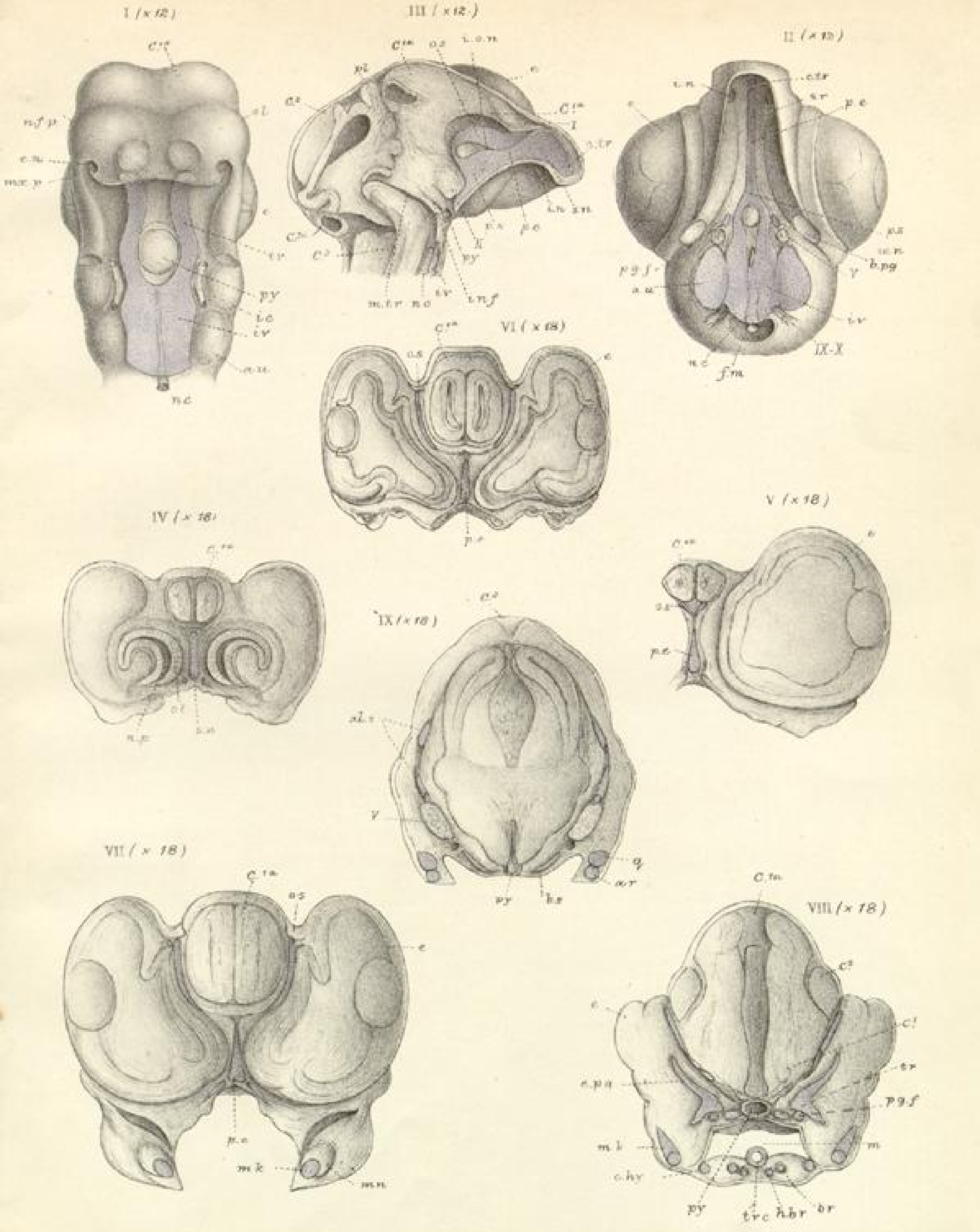
W. K. P. del. ad nat.
G. West. Jun. lith.

West, Newman

Zootoca vivipara *(adult.)*

(×15)

West, Newman & Co. imp.



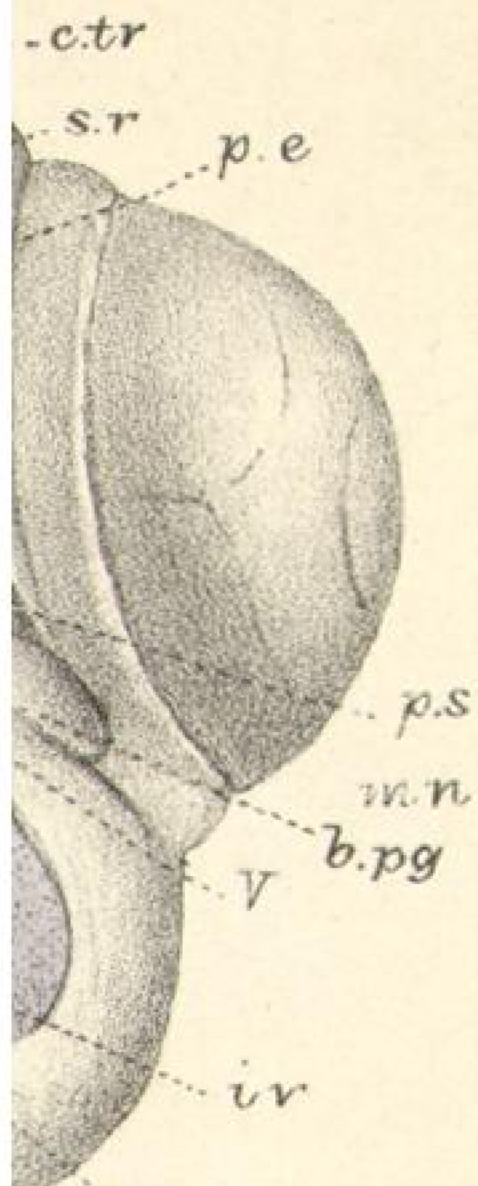
W.K.P. del. ad nat.
G. West Junr. lith.

West Newman & Co. imp.

Lacerta agilis.
Fig. I. 4th stage; II–IX 5th stage.

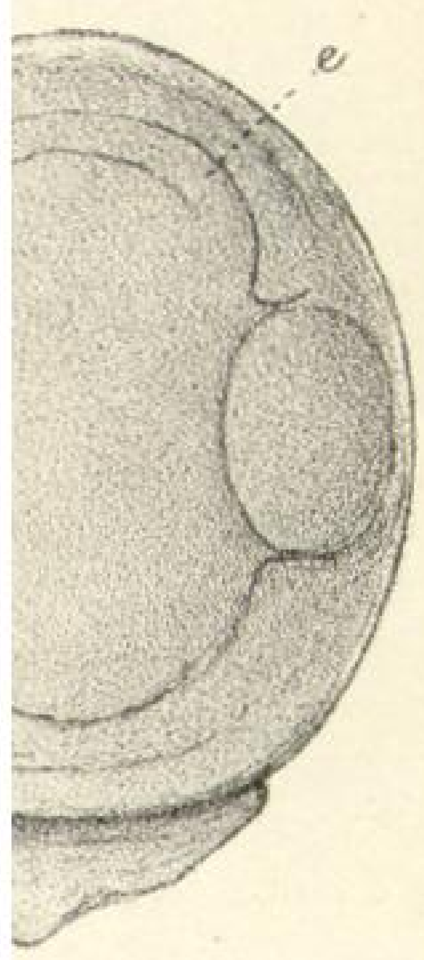

I (×12)
III (×12)
II (×12)
VI (×18)
IV (×18)
V (×18)
IX (×18)
IX-X
VII (×18)
VIII
c.tr
i.n
s.r
e
p.s
p.e
s.n
i.o.n
o.s
pl
inf
m.tr
nc
iv
py
ic
au
tr
ol
n.f.p
e.n
mx.p
al.s
V
q
ar
b.s
n.p
f.m
p.g.f
e.pg
mk

(× 12)

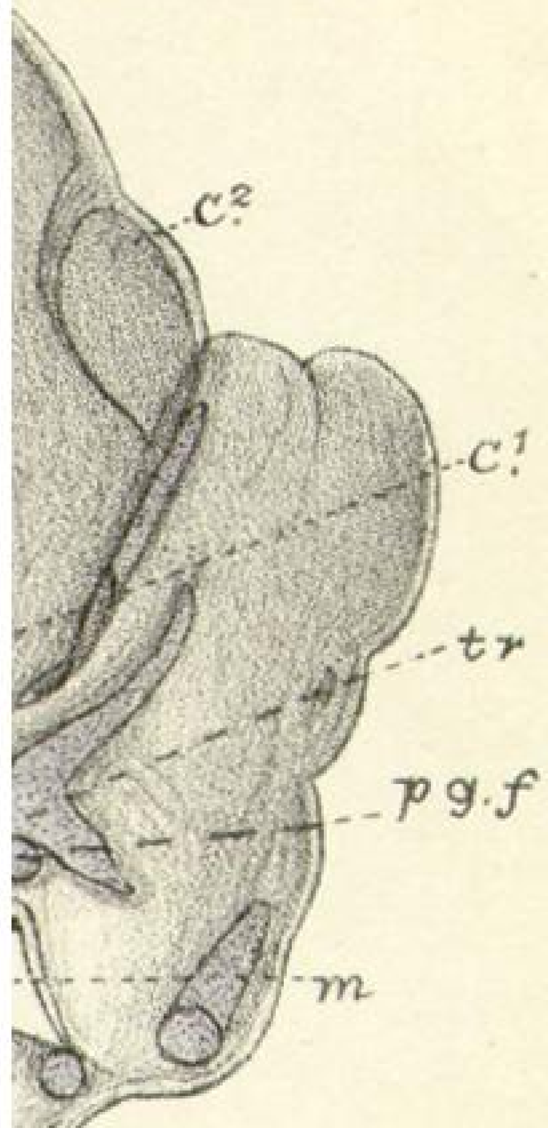


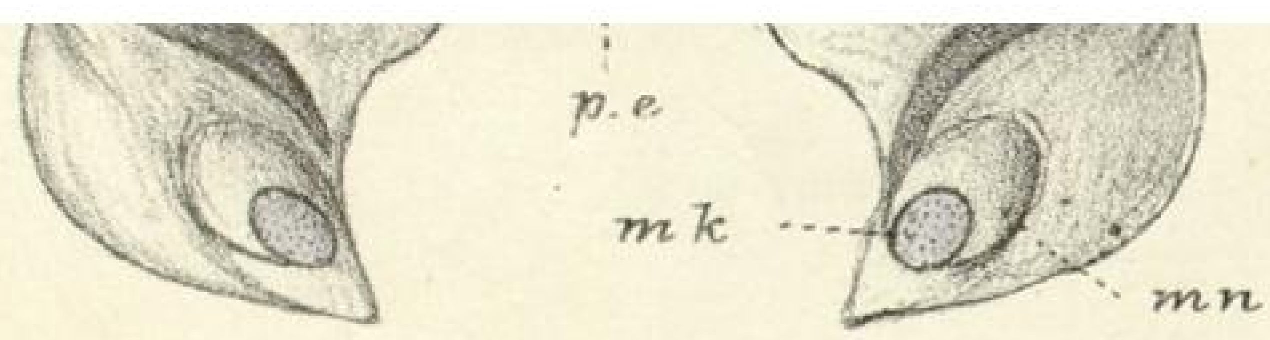
IX-X

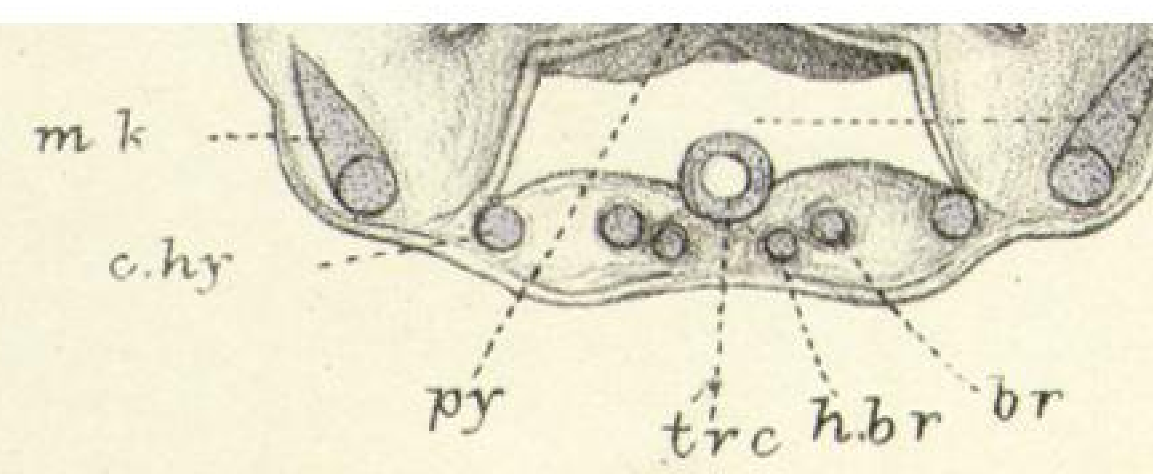
18)



VIII (× 18)





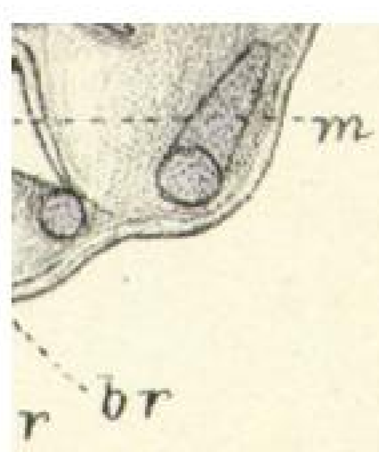


W.K.P. del. ad nat.
G. West Jun. lith.

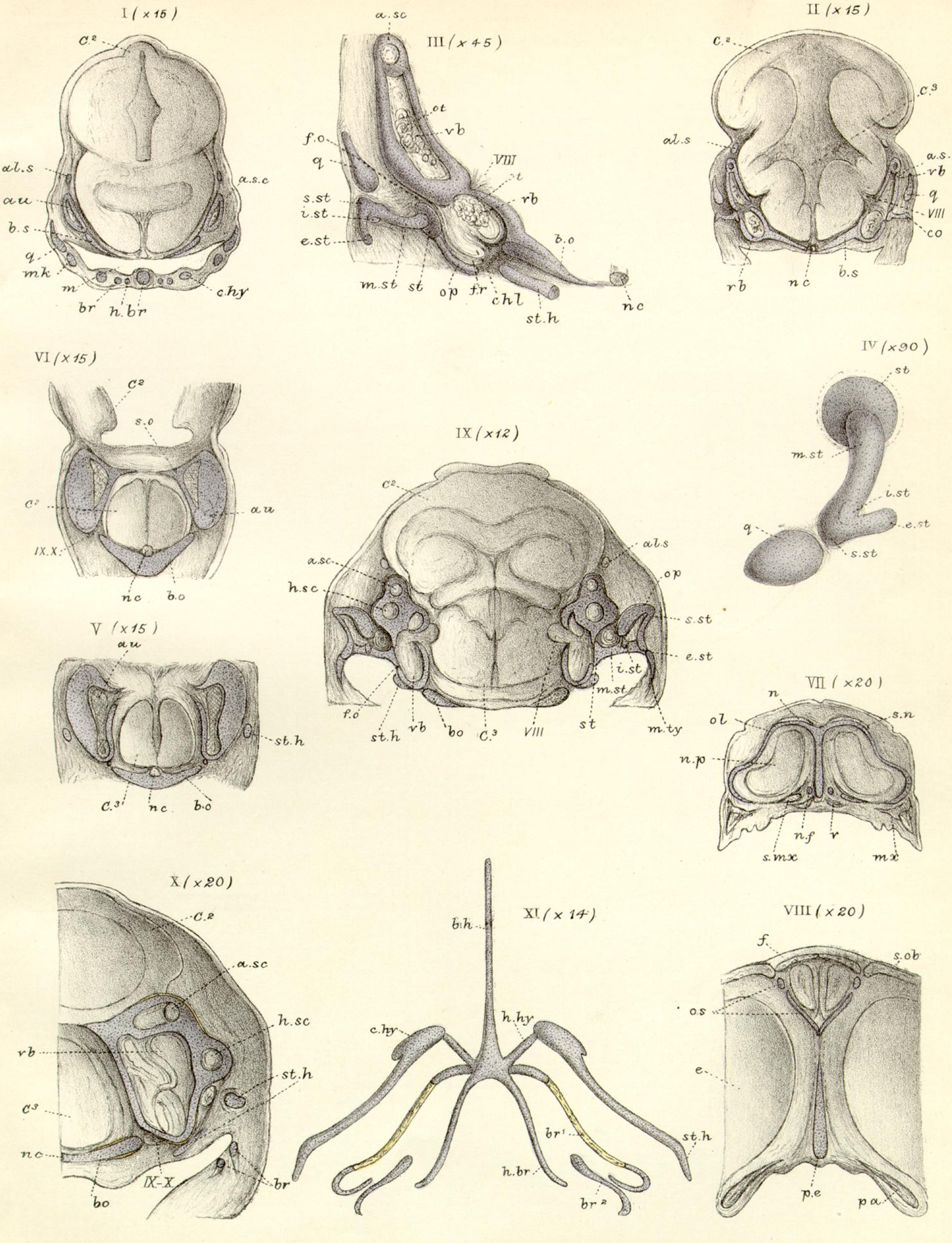
Wes

Lacerta agilis.

Fig. I. 4th stage; II–IX 5th stage.



West, Newman & Co. imp.

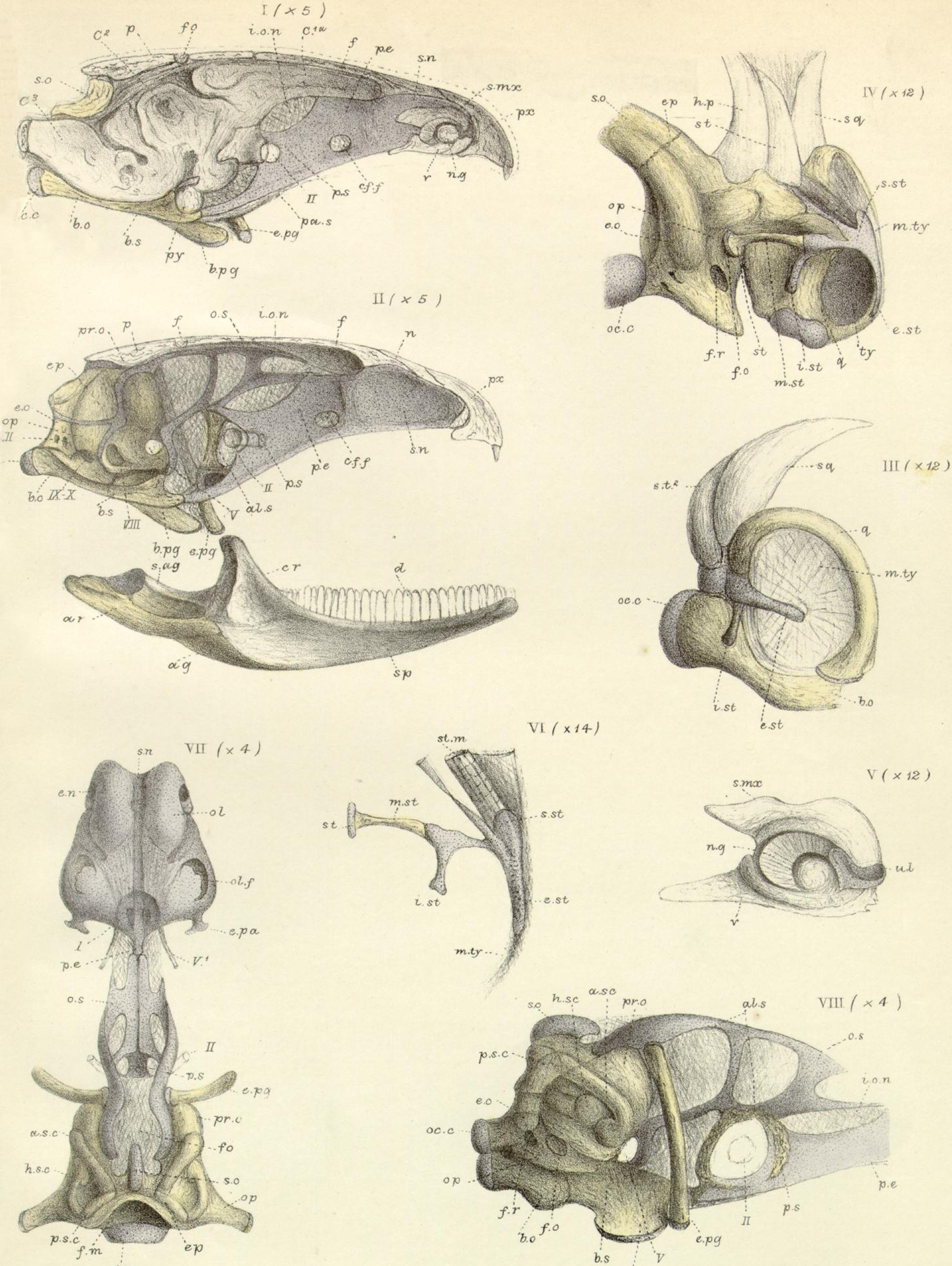


Lacerta agilis. Figs. I–VI 5th Stage.
Zootoca vivipara. " VI–X 6th. "

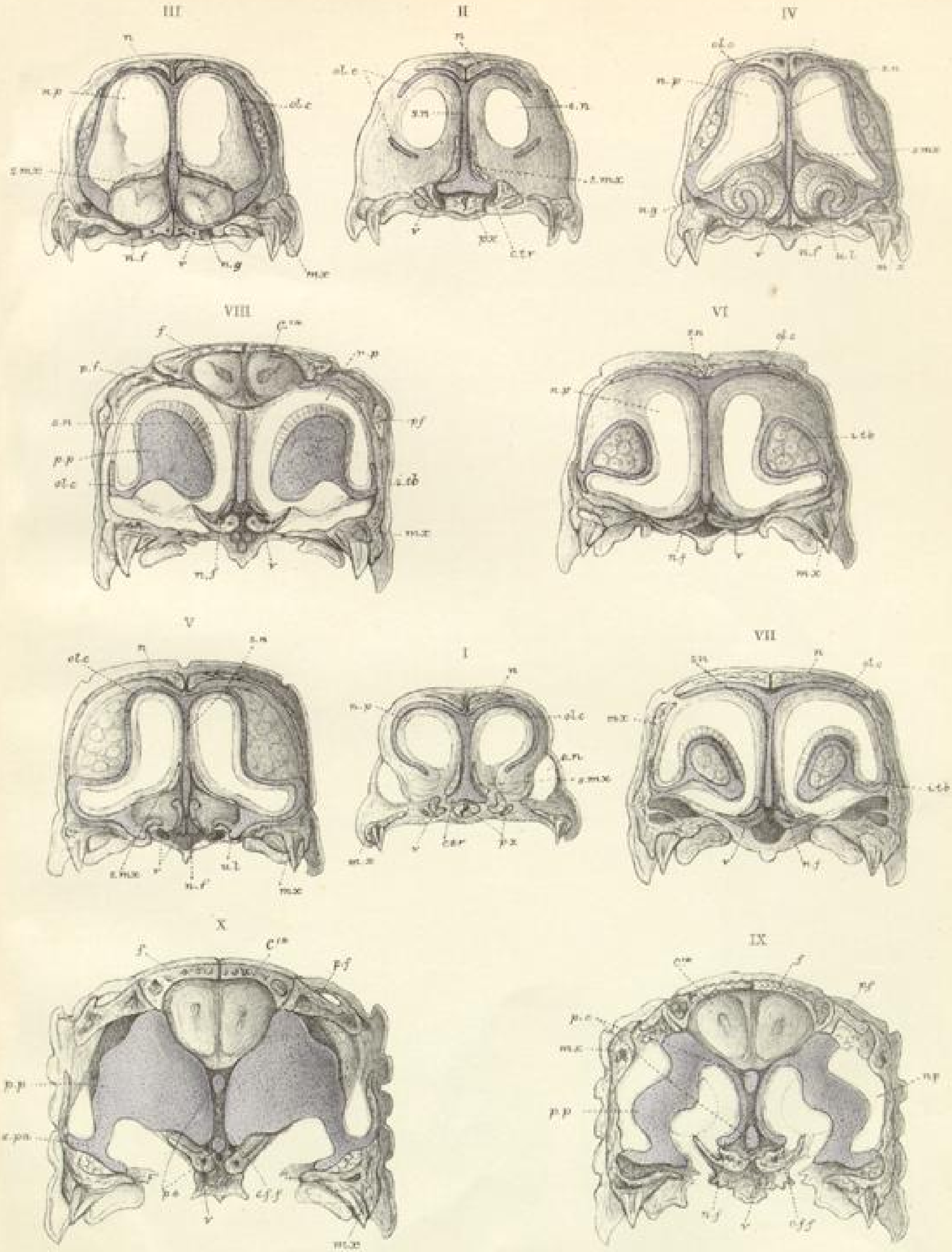
Zootoca vivipara.

Lacerta agilis. (*adult.*)

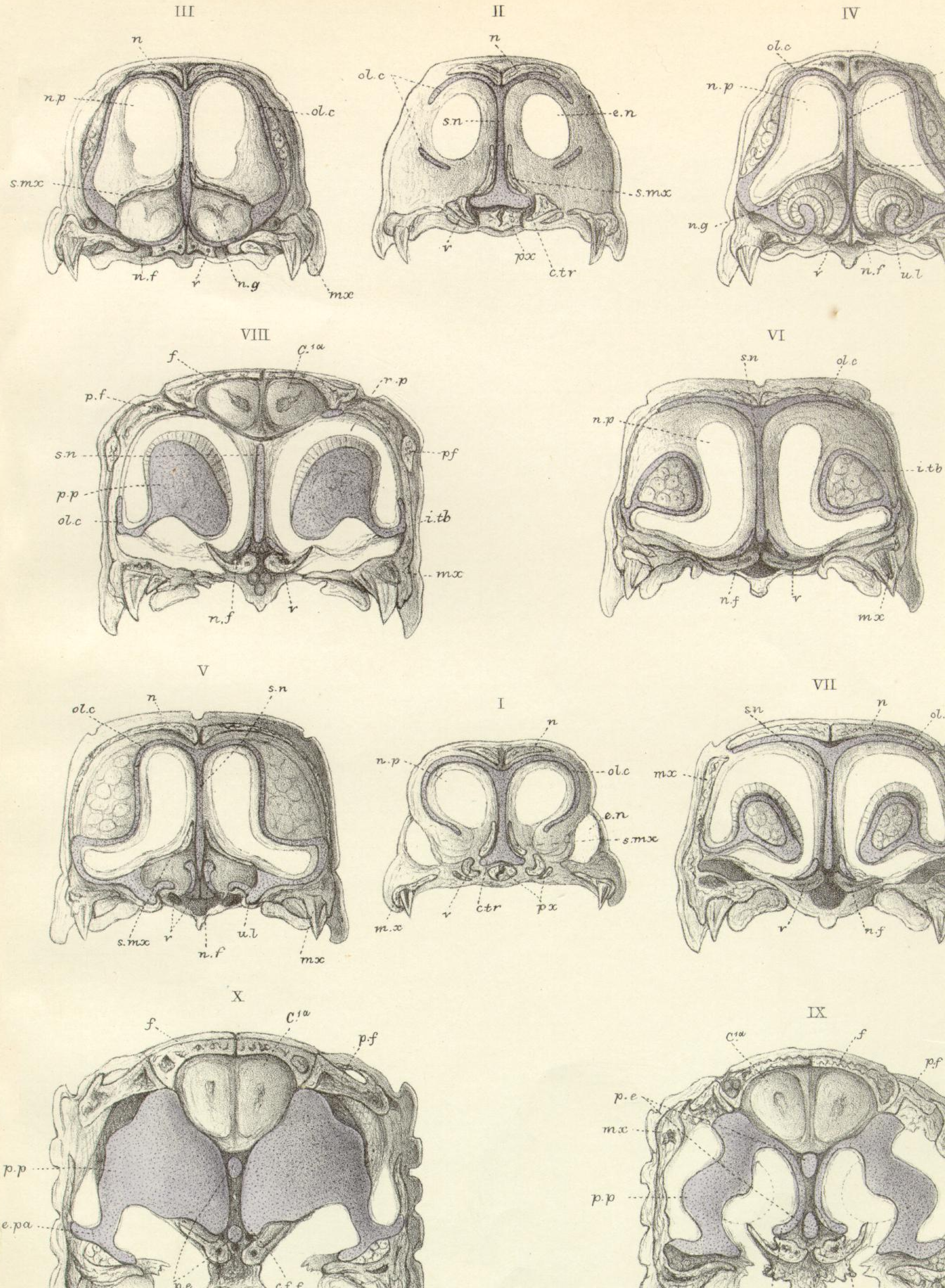
(× 5)



Lacerta agilis. Figs. I–VI (*adult.*)
„ viridis „ VII, VIII („)



Zootoca vivipara (*adult.*)
(× 15)


III
n
n.p
ol.c
s.mx
n.f
r
n.g
mx
II
n
ol.c
s.n
e.n
s.mx
r
px
c.tr
IV
ol.c
n.p
n.g
v
n.f
u.l
VIII
f.
C.1a
r.p
p.f
s.n
pf
p.p
ol.c
i.tb
mx
n.f
r
VI
s.n
ol.c
n.p
i.tb
n.f
r
mx
V
ol.c
n
s.n
s.mx
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u.l
n.f
mx
I
n
n.p
ol.c
e.n
s.mx
m.x
v
c.tr
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VII
s.n
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mx
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IX
C.1a
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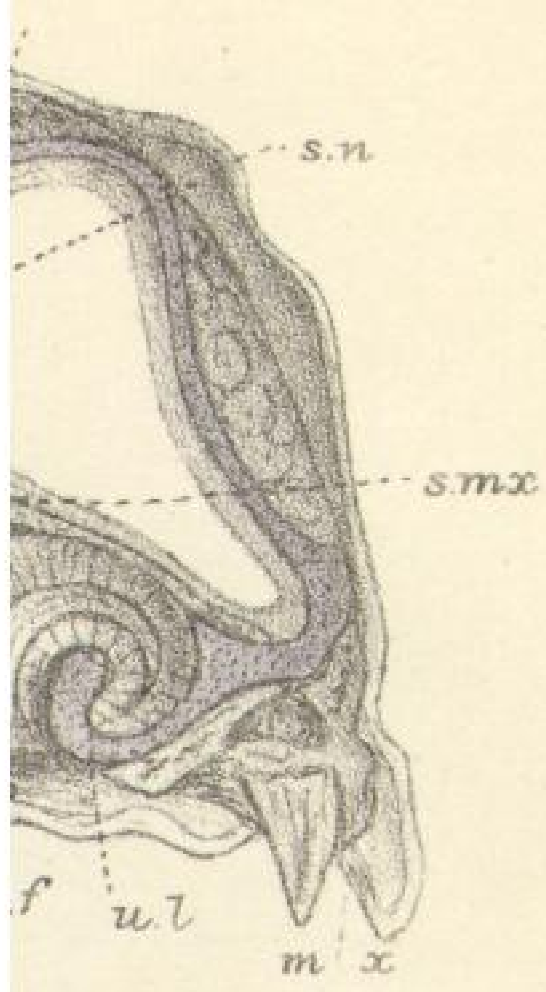
p.p


s.n
s.mx
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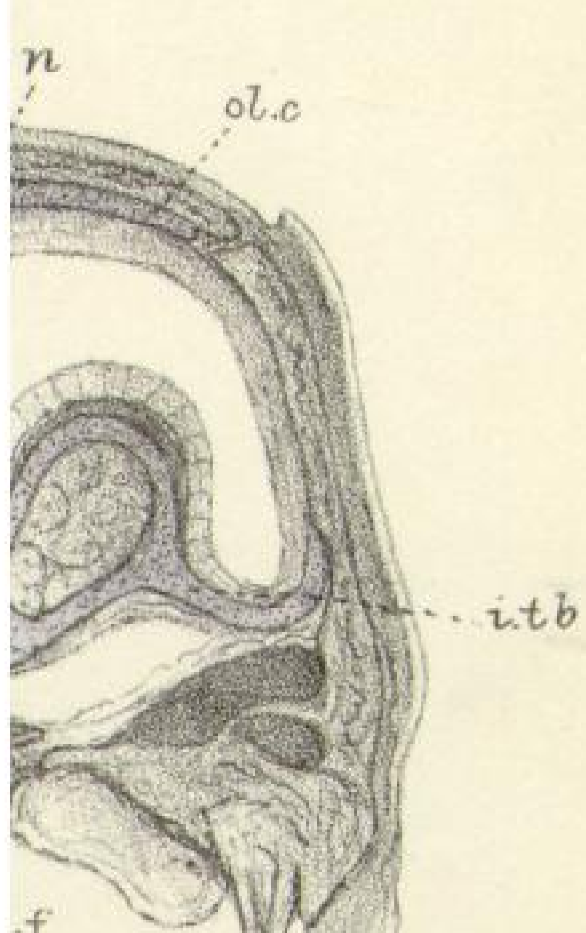
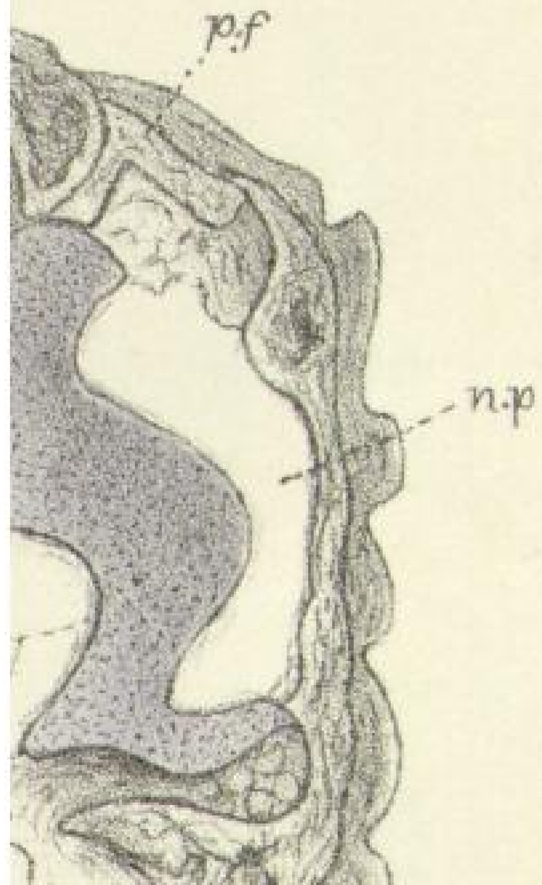
u.l
m
x


i.tb
x


n
ol.c
i.tb
f

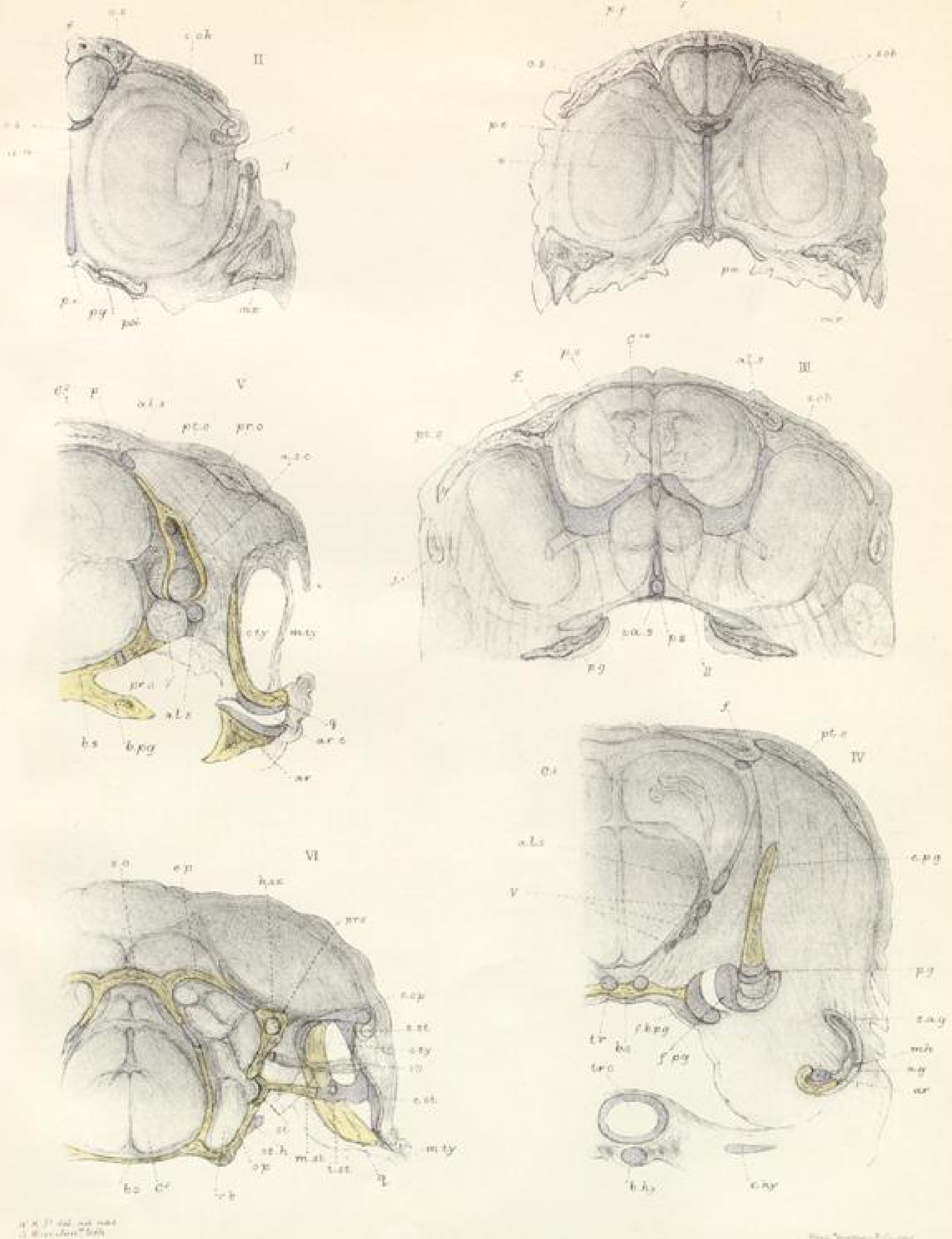

p.f
n.p

W. K. P. del. ad nat.
G. West Jun^r. lith.

West, Newma

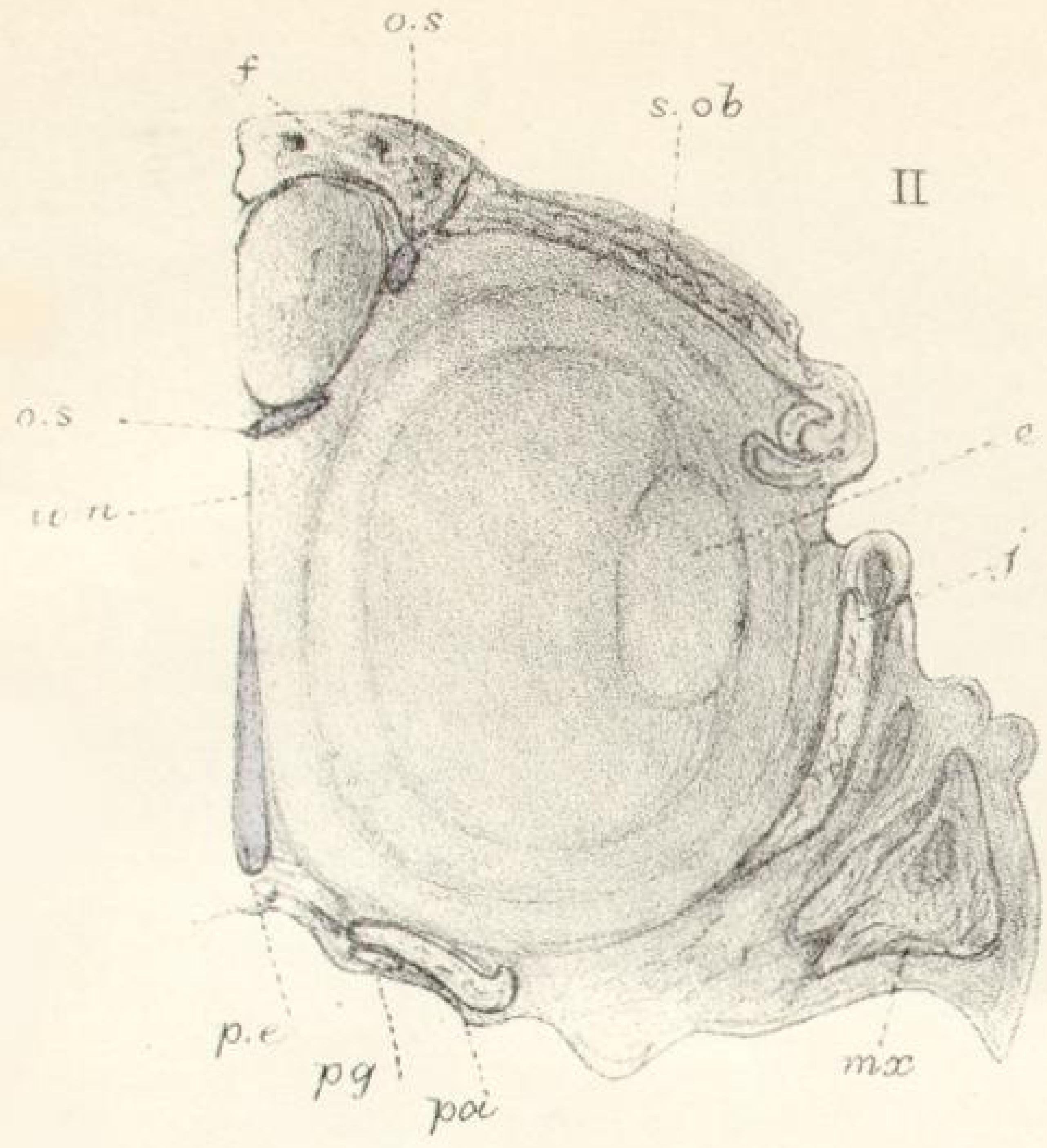
Zootoca vivipara (*adult.*)
(× 15)

West, Newman & Co. imp.



Zootoca vivipara (adult.)

(×15)



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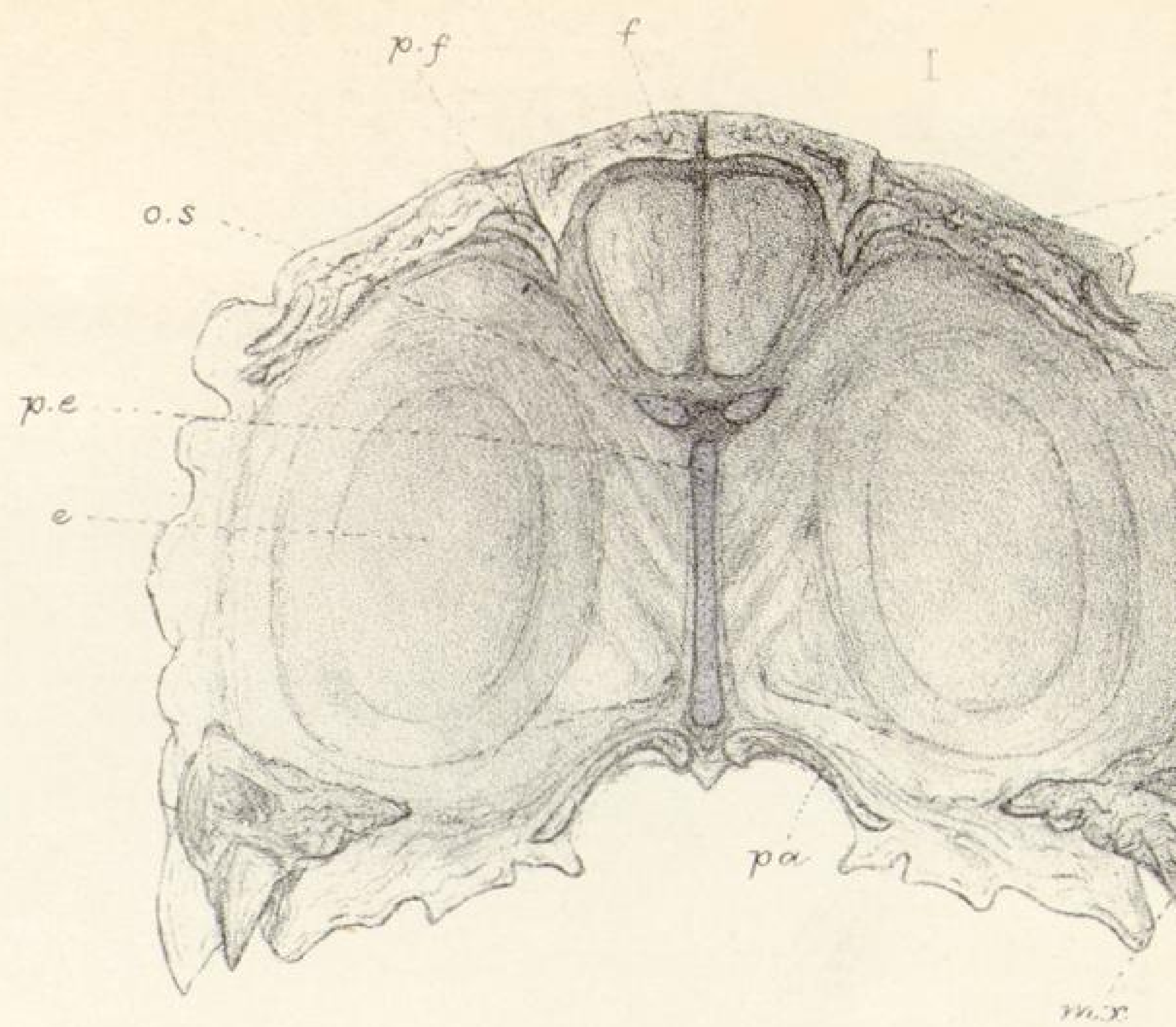

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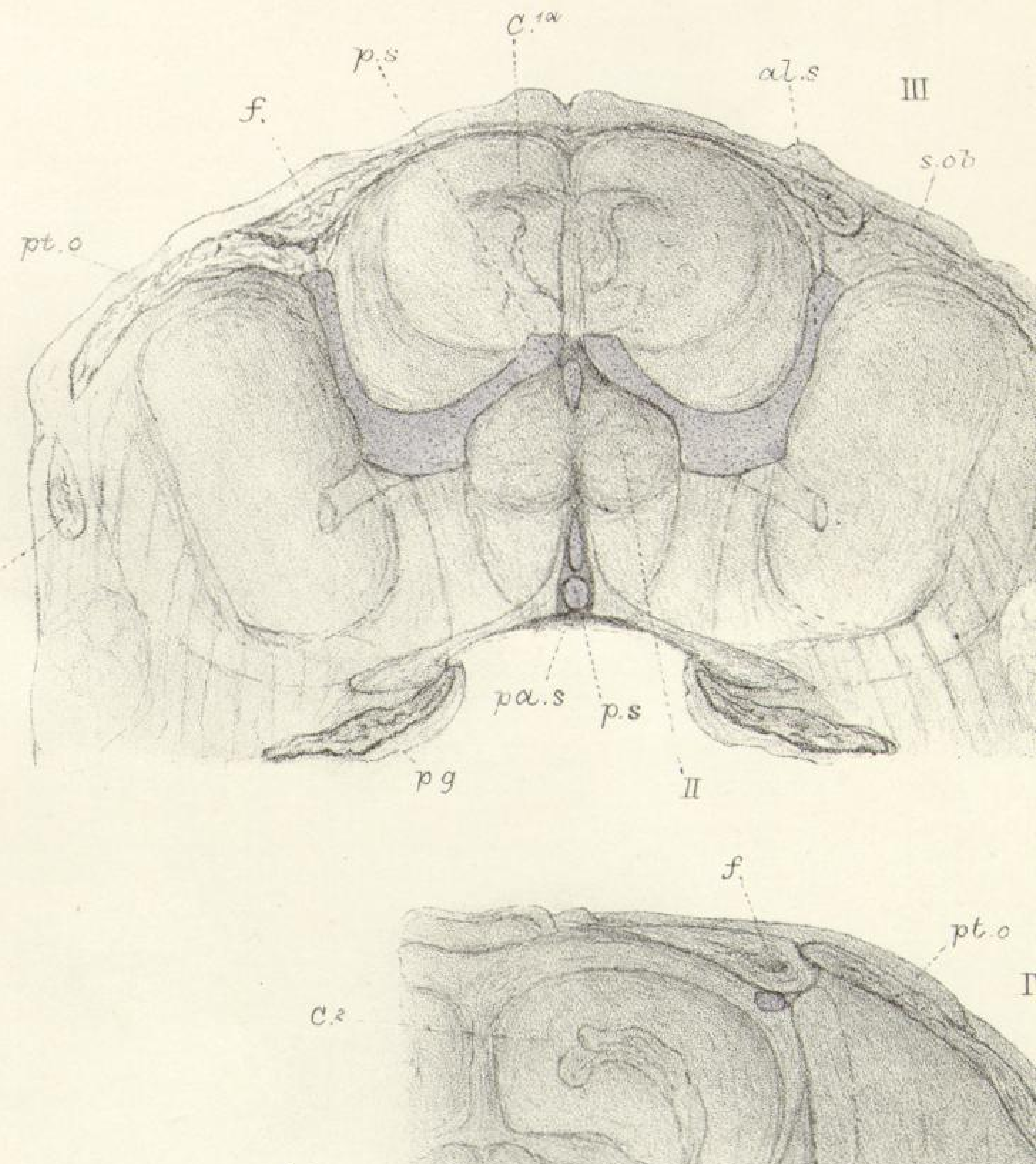

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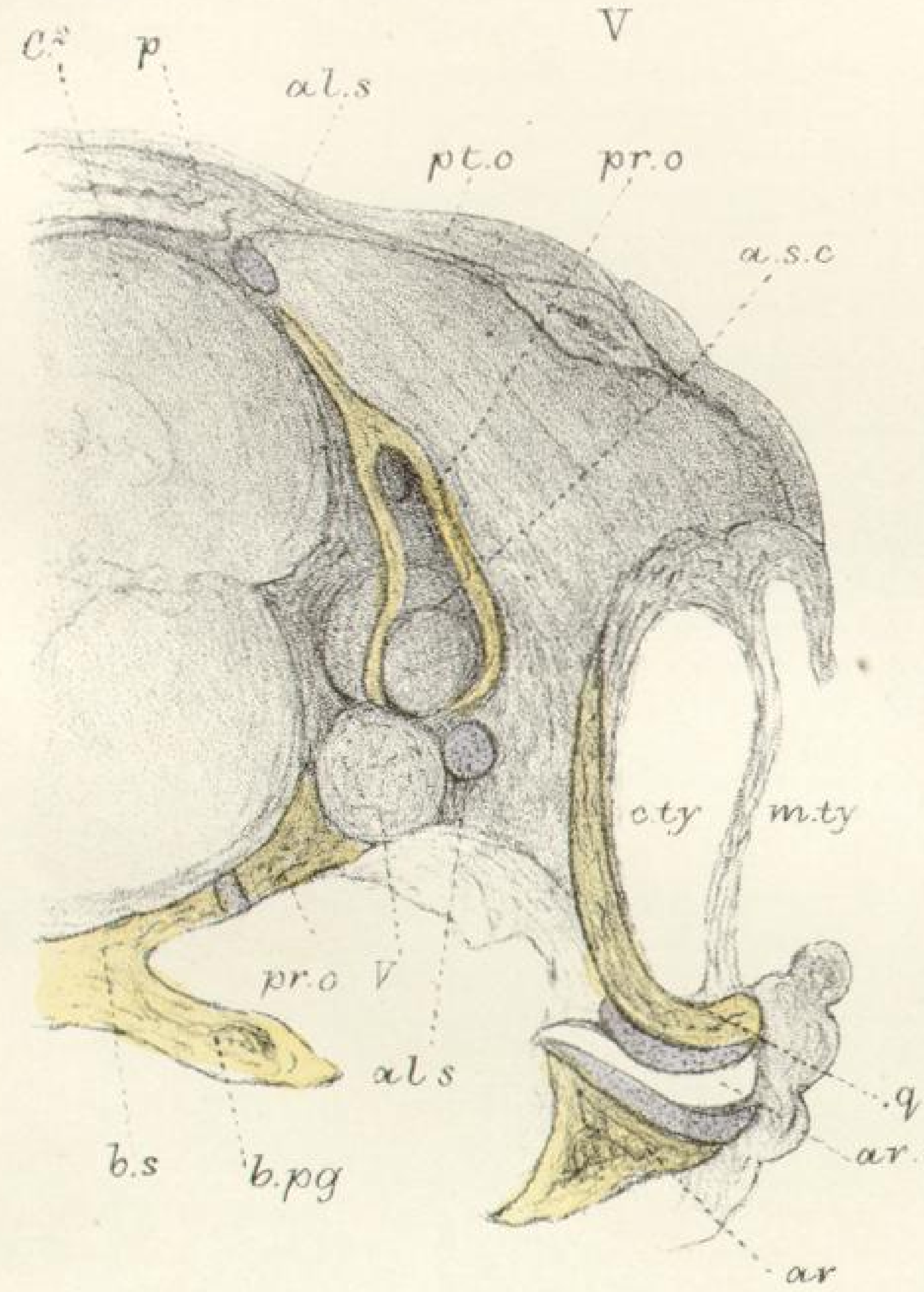

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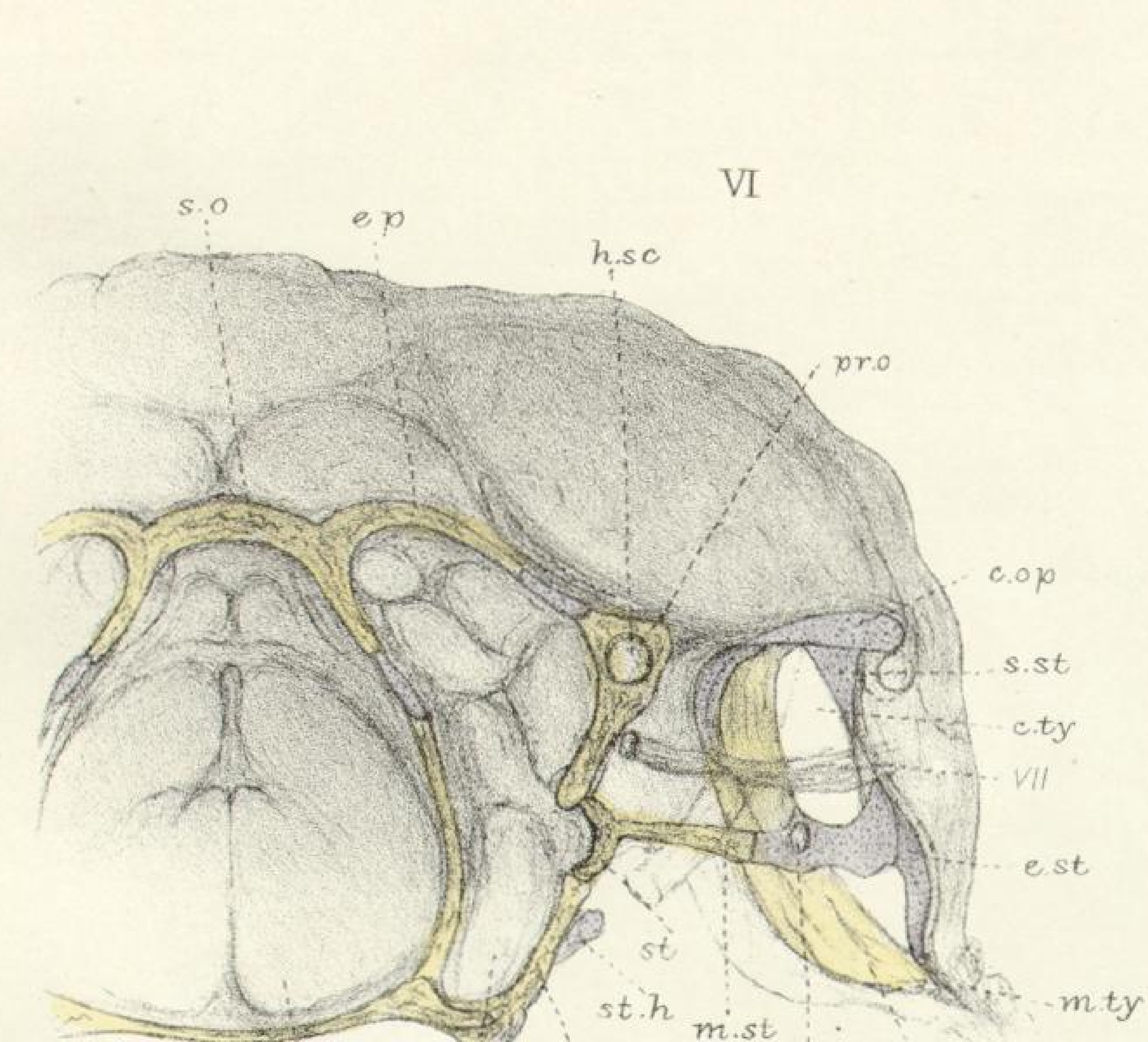
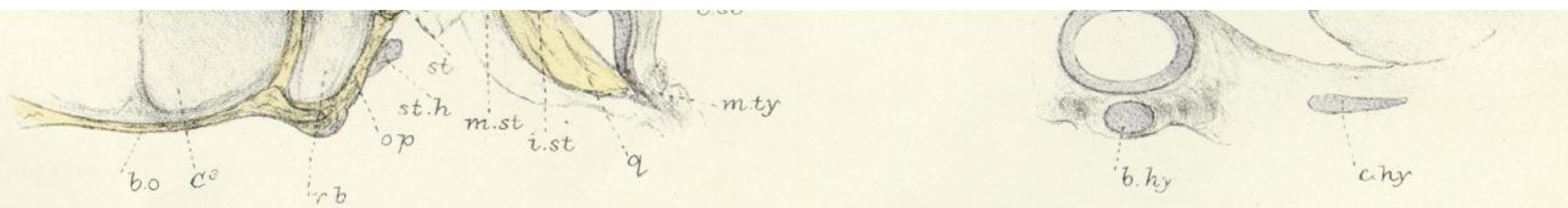
IV



VI

III

IV



W. K. P. del. ad nat.
G. West Jun.r lith.

West, Newm...

Zootoca vivipara (adult.)
(×15)

West, Newman & Co. imp.