FIGURE 1 (a).

1. Section 3.3 m.m. stage of O. punctatus through the region of eye showing the mesenchyme condensations in the anterior region of trabeculae (mes.to).
Microphotograph for Fig 1(a).

(Note: The sides are changed in the figure.)
FIGURE 1 (b).

T. section 3.3 m.m. stage of C. punctatus through the region of trigeminal nerve (tn.) showing the mesenchyme condensations in the posterior region of trabèculae (mes. tc.). The section also shows the relations of the internal carotid arteries (ic) and the vena capitis medialis or head vein (hv).
Microphotograph for fig. 14.
(Note: The sides are changed in the figure.)
FIGURE 2.

T. section 3.3 mm. stage of C. punctatus through the region of the facial nerve (f) and auditory sac (as). The section shows the mesenchyme condensation of the parachordals (mes. pc). Relations of the internal carotid arteries (ic) and the head vein (hv) are also seen.
Figure 3.

Wax model reconstruction of 3.5 mm stage chondrocranium of C. punctatus in dorsal view showing the parachordals (pc) widely separated from notochord (n) and the trabeculae (tc) in continuity with the parachordals. Rudiments of anterior basicapsular commissures (abc) are also seen.
chondrocranium

Dorsal view of 35 mm. Stage.  
O. punctatus

Fig 3
FIGURE 4.

The same model in side view showing the flexure of the trabecula (to).
Chondrocranium

Side view of 3.5 mm Stage
O. punctatus.

Fig. 4.
FIGURE 5.

Wax model reconstruction of 3.8 mm stage chondrocranium of O. punctatus in dorsal view showing the formation of trabecula communis (t. com.), auditory capsules (ac), occipital arches (oa), and the origin of lateral commissures (lc).
chondrocranium

Photograph of 3.8 m.m.
Stage Wax model in
Dorsal View. For
details see fig. 5.

Fig 5.

chondrocranium

Dorsal view of 3.8 m.m. Stage
O. punctatus
FIGURE 6.

The same model in side view showing the relation of Meckel's cartilage (mc), quadrate (qu), hyosymplectic (hys) with a notch behind, ceratohyal (ch) and the first three ceratobranchials (cb₁, cb₂, cb₃) to the neurocranium.
Fig. 6.

Side view of the Chondrocranium of 3.8 mm. embryo

O. punctatus
FIGURE 7.

The same model in ventral view showing the median copula (cop) and the cartilages of the visceral arch skeleton of figure 6.
Photograph of 3.8 mm. stage wax model in ventral view. For details see fig. 7.

Fig. 7.
Ventral view of Visceral arch skeleton of 3.8 mm. embryo of *O. punctatus*.
FIGURE 8.

wax model reconstruction of 4.6 m.m. stage chondrocranium of O. punctatus in dorsal view showing the formation of lateral commissure (1c), and the further development of the auditory capsules (ac).
Photograph of 4-6 mm Stage wax model in dorsal view. For details see fig. 8.

Fig. 8.
Dorsal view of Chondrocranium of 4-6 mm Stage. O. furnatus.
FIGURE 3.

The same model in side view showing the further development of quadrat (qu), the enclosure of the hyomandibular foramen (hf) and the appearance of hypo-hyal (hh) and fourth ceratobranchial (cb4).
FIGURE 10.

The same model in ventral view showing the relations of various cartilages of figure 9.
Chondrocranium

Photograph of 4-6 mm stage wax model in ventral view. For details see fig. 10.

Fig. 10.
Chondrocranium
Ventral view, 4-6 mm stage
O. fundulatus
Chondrocranium

Photograph of 5.2 mm stage wax model in dorsal view. For details see Fig. 11.

Chondrocranium

Photograph of 5.2 mm stage wax model in ventral view. For details see Fig. 13.
FIG. 11.

Wax model reconstruction of 5.2 mm. stage chondrocranium of O. punctatus in dorsal view showing the formation of the ethmoid plate (ep) with the internasal septum (ins), orbital cartilages (tm), prootic bridges (prb) enclosing the basicranial fenestra (bf), posterior basicapsular commissures (pbc), and the jugular foramen (jf).
Fig. 11. Chondrocranium.
Dorsal view. 5 1/2 mm. stage. O. punctatus.
**FIGURE 12.**

The same model in side view showing the development of the pterygoid process of the quadrate (ptp) and its articulation (epa and rpa) with the ethmoid plate (ep). The figure also shows the complete formation of the first three branchial arches each with four elements, pharyng-, epi-, cerato-, and hypo-branchials (pb, eb, cb and hb respectively). Fifth pair of cerato-branchials (cb5) and a pair of interhyals (ih) are also formed. Each interhyal articulates the ceratohyal (ch) with the hyosymplectic (hys) on the side.
FIGURE 13.

The same model in ventral view showing the relations of the various cartilages of fig 12.
Fig. 13. Chondrocranium
Ventral view, 5 1/2 mm. stage
O. punctatus.
FIGURES 14 (a & b).

Anterior reconstruction of the choilocrania at 6.3 m.m. and 7.5/stages of O. punctatus to show the formation of the olfactory foramina (fnm). Fig (a) shows the development of sphenoseptal (ssm) and sphenethmoid (sec) commissures from the anterior end of the orbital cartilages (tm). Fig (b) shows the fusion of the sphenoseptal commissures with the internasal septum (ins) and the fusion of sphenethmoid commissure with the lamina orbitonasalis (lon).
Fig. 14. (a) Anterior view of 6.3 mm stage
(b) " " 7.5 " "
O. punetanus.
FIGURE 15.

Wax model reconstruction of 7.5 m.m. stage chondrocranium of O. punctatus in dorsal view. The chondrocranium is completely formed by the development of nasal capsules (nc), tectum transversum (tt) and tectum synoticum (ts). The trabeculae (tc) in the middle are absorbed.
Fig. 15: Chondrocranium
Dorsal view, 7-5 mm stage
O. punctatus.
FIGURE 16.

The same in side view showing the relations of various cartilages of fig. 15.

Note: - The various elements of the branchial arches were not clearly visible from the side view of the wax model and so they have been shown continuous. Ventral view (fig 17) makes the elements clearly visible.
FIGURE 17.

The same in ventral view. The fourth branchial arch is also complete now with the usual four elements (ph, eb, cb and hb).
Fig. 17. Chondrocranium

Ventral View, 7.5 mm Stage
O. punctatus.
FIGURE 18.

Reconstruction of 7.5 mm stage chondrocranium of O. punctatus in dorsal view showing the relations of the various arteries, veins, nerves and eye muscles of the chondrocranium.
Fig. 18. Chondrocranium

Dorsal view showing the relations of arteries, veins, nerves and eye muscles at 7.5 mm stage

O. punctatus.
FIGURES 19, 20, 21, 22, and 23.

T. sections 7.5 m.m. stage of O. punctatus through successive regions of the nasal capsule (nc) to show the relation of the various cartilages and the olfactory nerve (on).

Figure (19) shows the ethmoid plate (ep) at its anterior most end.

Figure (20) shows the internasal septum (ins) at its anterior end.
Figure 21 shows the position of the lamina orbito-nasalis (lon) and the olfactory nerve (on).
Fig 21.
T.S. 7.5 mm. stage

Microphotograph
for fig. 21.
Figure (22) shows the foramen olfactorium evehens (eof), the foramen olfactorium edvehens (aof), and the olfactory nerve (on) traversing the orbit.
Microphotograph for fig. 22.
(Note: The sides are changed in the figure.)
Figure (23) shows the broad posterior end of the internasal septum and the roofless nasal capsules.
Microphotograph for fig. 23.
Arteries of the head of *O. punctatus* are compared with those of *Amia* and *Salmo*; fig (a) shows the arteries in *Amia* in which the pseudobranch (ps) receives blood from internal carotid artery (ic) through a secondary afferent pseudobranchial artery (aps) which is connected by a connection with the orbital artery (ora); fig (b) shows the arteries in *Salmo* where the afferent pseudobranchial artery has no connection either with the internal carotid artery or the orbital artery; Fig (c) shows the corresponding arteries in *O. punctatus*, where the afferent pseudobranchial artery is directly connected with the orbital artery. The efferent pseudobranchial artery (eps) does not meet the internal carotid.
Fig. 24. Arteries of the head in (a) Amia, (b) Salmo, and (c) Ophiocephalus punctatus.
RELATIONS OF THE TRABECULA TO THE ARTERIES ARE SHOWN:
fig (a) shows the condition in _Salmo_ where the efferent pseudobranchial artery (eps) goes beneath the trabecula (to) to meet the internal carotid artery (ic), and the ophthalmica magna artery (om) comes out from the internal carotid artery above the trabecula; fig (b) shows the condition in _O. punctatus_ where the efferent pseudobranchial artery and the ophthalmica magna artery have the same relations with the trabecula but the efferent pseudobranchial artery does not meet the internal carotid artery and becomes continuous with the ophthalmica magna artery; fig (c) shows the hypothetical condition where the relations are the same as in _Salmo_ but the efferent pseudobranchial artery and the ophthalmica magna artery have met outside the trabecula; fig (d) shows the condition in _Selachii_ where the artery which lies beneath the trabecula in hypothetical type is reduced and hence the efferent pseudobranchial artery appears to join the internal carotid artery above the trabecula.
Fig. 25. Relations of the trabecula to the arteries
(a) Salmo, (b) Hypothetical, (c) Selachii, (d) O. puntatus.
FIGURE 28.

T. section 7.5 m.m. stage of *O. punctatus* through the region of the trigeminal nerve (tn) showing the orbital artery (ora) and its branches; afferent pseudo-branchial artery (aps) going to the pseudobranch and mandibular artery (ma) going to the mandibular arch.
FIGURE 27.

T. section 7.5 m.m. stage of O. punctatus through the region of the facial nerve(f) showing the trigemino-facialis chamber to be divided into:

pars ganglionaris portion (gtfc) lodging the facial ganglion and pars jugularis portion (jtfc) lodging the head vein (hv) and the orbital artery (ora).
FIGURE 23.

T. section 7.5 m.m. stage of O. punctatus through the region of the facial nerve (f) showing the relations of the hyomandibular branch of the facial nerve (hbf), the head vein (hv), orbital artery (ora) and hyosymplectic (hys).

FIGURE 23.

T. section 7.5 m.m. stage of O. punctatus through the region of the facial nerve (f) showing the hyomandibular branch of the facial nerve (hbf) passing out through the hyomandibular foramen (hf).
Microphotograph for fig. 29.
FIGURE 30.

T. section 7.5 m.m. stage of _O. punctatus_ through the region of the auditory nerve (aun) showing the smooth prootic bridge (prb) without any myodome (md).

FIGURE 31.

T. section 7.5 m.m. stage of _O. punctatus_ through the region of glossopharyngeal nerve (g) showing its relations with the head vein (hv) and the auditory capsule (ac).
Microphotograph for fig. 30.

Fig. 31. T.S. 7.5 mm stage.

Fig. 30. T.S. 7.5 mm stage.
FIGURE 32.

T. section 7.5 m.m. stage of *O. punctatus* through the region of the basi-capsular fenestra (bcf) showing the passage of the glossopharyngeal nerve (g). Tectum synoticum (ts) is also seen.
Microphotograph for fig. 32.

Fig. 32. T.s. 7.5 mm. Stage
FIGURE 33.

T. section 7.5 m.m. stage of *O. punctatus* through the region of the vagus nerve (v) showing its passage through the jugular foramen (jf).
Microphotograph for fig. 33.
FIGURE 34.

T. section of *Amia* through the region of facial ganglion (f) to show the relation of various arteries and veins to the auditory capsule (ac) (after deBeer).

FIGURE 35.

T. section of *Salmo* through the region of facial ganglion (f) showing the trigeminofacialis chamber (gtfc and jtfc), and the myodome (md) along with the posterior (pr) and anterior (ar) recti muscles (after deBeer).
Fig. 34. T.S. Amia (after de Beer).

Fig. 35. T.S. Salmon (after de Beer).