AN EARLY DOLPHIN EMBRYO (STENELLA COERULEOALBUS) IN SERIAL SECTIONS

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This 4.2 mm. dolphin embryo is probably the youngest to be completely described. A 12 mm. embryo was described by H. Hosokawa in 1955 in complete serial sections [1]. Embryos of the humpback whale were studied and described by Stump, Robins and Garde [2]. The present embryo was taken at Kawana on Izu peninsula Japan, Dec. 7, 1960. The dolphin drive which takes place twice a year was rather light yielding 300 animals whereas some drives reach 1000. Of dolphins killed in this drive approximately half were females. Several species were included but Stenella predominated. Females were of all ages but about twenty younger ones were examined and, using the corpora lutea as indicators, ten uteri were removed. Three of the ten contained blood due to rough handling in killing and the remainder yielded only one embryo. The others apparently had aborted.

This result together with the fact that only one embryo could be secured in a second drive a month later, from approximately fifty females in a catch of 600 dolphins, leads one to think that the rate of reproduction in this cetacean is extremely low. Dr. T. Ogawa of Tokyo University had insisted that young embryos could be secured only in early December because the period of breeding is probably late October or early November. The size of the present embryo indicates an age of about one month and confirms his estimate. A second embryo of 26 mm. taken Jan. 20, 1961 is about 2·1/2 months old and again confirms his judgement of the breeding period. This data also fits the second of the breeding periods for the Fin Whale deduced from International statistics [3]. According to Stump, Robins and Garde [2] the mating is at a maximum for the humpbacked whales in August in the eastern and western Australian waters.

The external features of the embryo are remarkable. Fig. 1. The external appearance of a whale embryo of the same dimensions was given by Dr. Nishiwaki in 1957 [4]. In our dolphin embryo the whole trunk is a helix of one full turn about the body stalk as an axis.

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Various degrees of spiralling may be seen in many mammal embryos and the author has two human embryos of the same dimensions and equal amount of torsion.

The embryo was removed from a gestation sac 65 mm. in length. Fig. 2. The placenta is extremely simple like that of the pig and separated from the uterus under a small stream of water. A detail of corpus luteum of the maternal ovary is seen in Fig. 3. Its dimensions were 32×36 mm. The gross cut surface of this corpus luteum is homogeneous. Those taken from uteri suspected of recent abortion showed a more cordlike structure.

These serial sections were cut from celloidin at 10 microns and were stained with hematoxylin and eosin. Standard orientation presents the midbrain first. Section 14, Fig. 4, shows the germinal zone of the brain and surrounding marginal zone. No mantle zone is discernable. By section 20, Fig. 5, the narrow cleft opening into the third ventricle and expansion of the fourth ventricle are distinguishable. The roof of the hindbrain (metencephalon) is already folded although it is thick. Small extensions of the cerebral plexus foreshadow the carotid and cardinal systems. Section 31, Fig. 6, shows the forbrain and hindbrain separated by the cephalic flexure. Neural crest may be distinguished in the region which becomes the trigeminal ganglion. Note the skin depression and its adherence to the neural mass. An interesting detail Fig. 7, is from the angle between forebrain and optic vesicle. Here may be seen a stream of basophil cells still attached at the angle and stretching down into the mandibular arch. They are said to take an important part in the structure of that arch.

In section 38 Fig. 8 the optic vesicles are seen to be narrow extensions of the forebrain barely contacting the epidermis. There is no lenticular thickening and no terminal expansion of the vesicle. Basophil cells are seen both cranial and caudal to it. The infundibulum of the third ventricle does not contact the notochord any longer. The latter is fused to the roof of the preoral gut. The hindbrain has developed neuromeres between the potential origins of fifth and seventh nerves. Note that the seventh ganglionic aggregate also contacts the epidermis closely.

By section 43 Fig. 9 we reach the middle of the open octocyst. Asymmetry due to torsion begins to appear. By section 52 Fig. 10 the otocysts are cut ventrally and the ganglionic primordia of nerves VIII-IX are indicated. The anterior cardinal vein becomes a prominent landmark. First and second aortic arches and their dorsal connections are present. The preoral gut (Seessel's pouch) between the first arches ends on the pharyngeal membrane. Cranial to that are two diverticula of Rathke's stomodeal pouch lateral to the infundibulum. The anterior neuropore is still open over the telencephalon.

By section 57 Fig. 11 the stomodeum opens upon the left side and the unruptured membrane is suspended between mandibular arches. First and second arches are seen in cross section together with their associated fifth and seventh ganglionic primordia. The first pouch reaches its closing plate and the first furrow does the same. The last trace of otocyst is seen. Any occipital somites between this and the first cervical are already fused into one mass. Note the small size of the brain and the thin terminal lamina. The tip of the head is in section 65 Fig. 12. The second branchial furrow is on the left together with an unexplained endodermal microvesicle. The first somite to show a definite derma-myotome is present. Ganglion X is indicated.

Section 78 Fig. 13 shows the margin of the second somite on the left and the cervical opercular bulge candal to three well defined arches of nearly equal size. The descending aorta is present. The spinal cord shows no differentiation of mantle layer and there is no evidence of spinal ganglia. Thick endodermal epithelium indicates future developments. Most of the medial surface of the first arch is ectodemal reaching back to the deep phayngeal membrane. By section 83 we see the floor of the pharynx and note the ventral aorta reaching the first arch. Second and third pouches reach closing plates without perforation. Somite three begins to show on the left.

By section 96 Fig. 14 the bulbus arteriosus shows at the base of the second arch and a section of truncus arteriosus lies in the pericardial cavity. Mandibular arches have not yet closed into a symphysis. The pharynx is broad at the fourth pouches. Descending aortae lie just ventral to the third somite. The spinal cord is thick and the lumen narrow. It shows no distinction into basal and alar plates. By section 102 Fig. 15 the pharynx narrows and the thickened pulmonary ridges develop just lateral to the thick endoderm foreshadowing lung buds. The truncus arteriosus and part of the ventricle show a suspended endocardial tube and many extravascular erythroblasts.

In section 106 Fig. 16 the ventricular loop gives way to the central atrium. Pulmonary ridges are prominent but the pharynx narrows. Neither glottis nor trachea is present. Somite four appears on the left. Lateral mesocardia containing common cardinal veins appear in section 120 and are more symmetrically developed in section 126 Fig. 17. This results in forming a pair of pleuroperitoneal canals. Between these just ventral to the gut are the cordlike diverticula of the liver and gall bladder. The latter does not get beyond a rudimentary stage. Pancreatic diverticula also are present but difficult to demonstrate.

Somite five is present. Still in the segment of five in section 142 Fig. 18 the liver cords extend profusely and lateral diverticula of the duodenum are evident. The face of the liver lining the pericardial cavity is the septum transversum. Liver extends to the lateral walls and incorporates vitelline and allantoic veins into hepatic sinusoids.

Section 159 shows the intestinal portal as the gut opens up opposite somite six and the liver is separated into lobes containing paired vitelline or omphalomesenteric veins. The epithelial and vascular structure of the yolk sac wall are well displayed in folded membranes. Blood making functions have already been largely transferred to the general circulation. In section 168 Fig. 19 the right vitelline vein passes upward toward the liver. Heavy parietal walls indicate the future limb buds.

In section 174 the coelom opens laterally to the extraembryonic coelom. At somite seven there is the first appearance of mesonephric duct cranial to any tubules. Limb primordia are still just parietal thickenings.

Section 186 Fig. 20. The spiral torsion of the trunk is evident in somites 7–8. The coelom on both sides is open. Aortae remain double. Mesonephric tubules appear in the nephric ridge. The gut is again closed by the folded yolk sac. By section 193 the whole border of the loop is cut in a half circle. The wall of the yolk sac is central to the loop. Ten mesonephric tubules appear. By section 198 Fig. 21 a ninth somite is added and the coelom is seen extending to the caudal end. Section 207 Fig. 22 cuts the full line of somites from nine through twenty-nine. The last somite ends in the unsegemental lateral mesodermal plate. The whole remaining mesonephros is displayed with its duct. There are approximately 2·1/2 tubules per somite but neither glomeruli nor cloacal connection to permit function.

Shifting caudally to section 220 Fig. 23 the spiral is cut through the open posterior neuropore. Dermatome, myotome and sclerotome of each somite are distinct and the dorsal intersomitic invasion by somatopleure is in process.

By section 223 Fig. 24 the notochord terminates in the primitive knot and the cloacal plate is indicated. The superior mesenteric artery descends and the gut is defined back to the rectum. Section 235 Fig. 25 shows the cloacal expansion to the anal plate and proctodeum on the one hand and the dorsal wing leading to the mesonephric duct on the other. These features are further expanded in section 248 Fig. 26. This sectiton passes through the urachus (allantoic duct) into the thick walled allantois. Note that at this stage it is much less vascular than the yolk sac. The urethral plate is better shown in section 251. Finally section 275 Fig. 27 shows the expanding end of the allantois extending caudally through the gut loop.

REFERENCES

1) HOSOKWA H. (1955). Cross sections of a 12 mm dolphin embryo. Scientific Reports Whales Research Institute, 10; 1-73.
2) STUMP C. W., J. P. ROBINS and M. L. GARDE (1960). The development of the embryo and membranes of the humpback whale, megaptera nodosa (Bonnaterre). Austr. J. Marine and Freshwater Research 11; 365-368.
3) NAKTGEBORNEN C., E. J. SLIJPER and W. L. VAN UTRECHT (1960). Remarks on the period of conception, duration of gestation and growth of the fetus of the fin whale based on data from International Whale Statistics. Norsk. Hvalfangst Tidende, 1960 #3; 313-319.
4) NISHIWAKI M. (1957). Very smal lembryo of cetacea. Scient. Rep. Whales Res. Institute 12; 191-2.

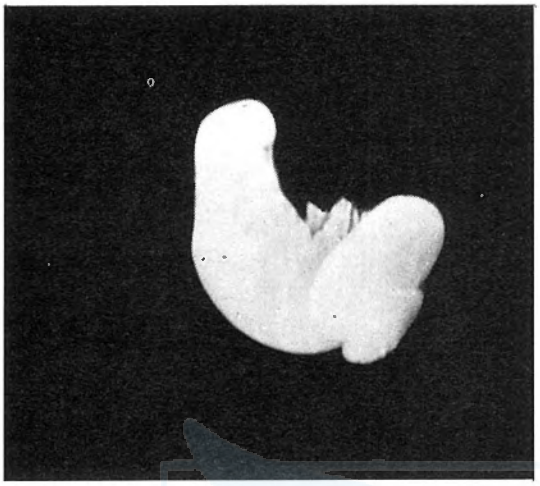

Fig. 1. 4.2 mm dolphin embryo. The trunk shows a spiral of one full turn about the allantois and yolk sac.

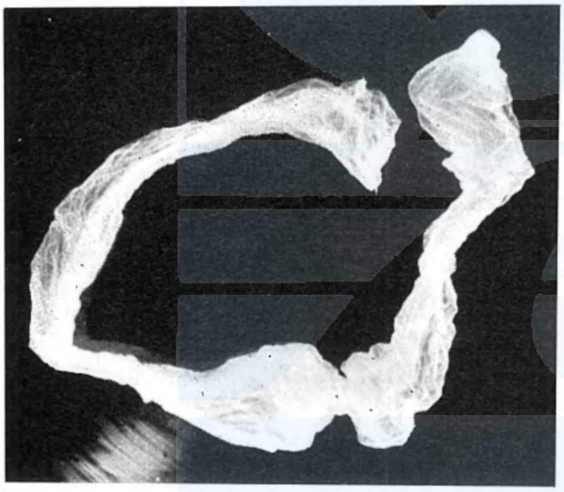

Fig. 2. Gestation sac of 65mm containing a 4.2 mm embryo dolphin.

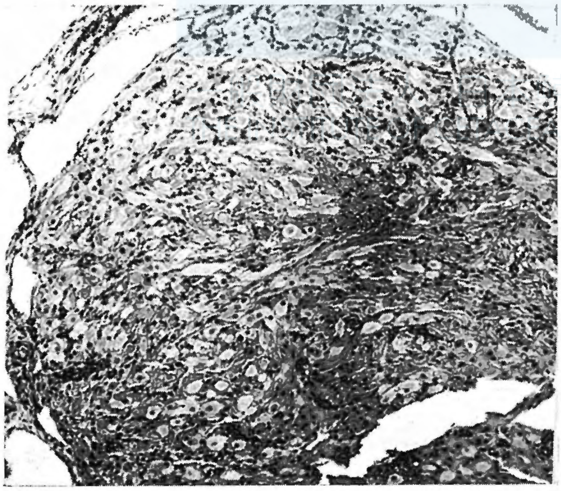

Fig. 3. Corpus luteum of the dolphin of one month gestation.

This is a small segment of the 32×36 mm corpus luteum.

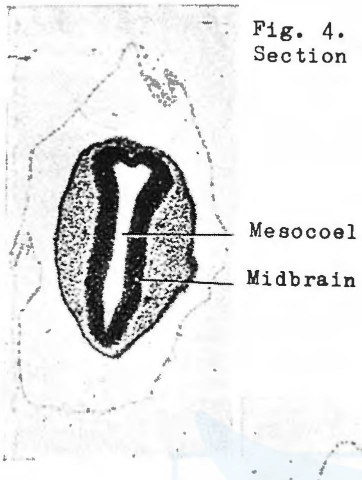

Fig. 4.
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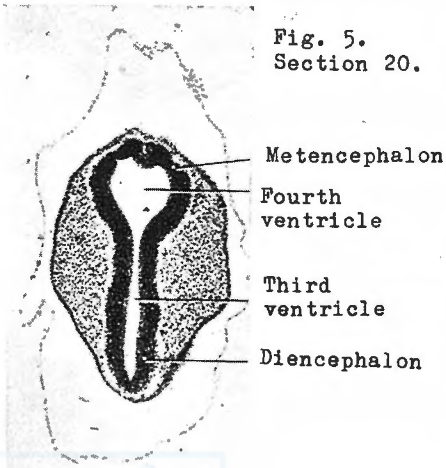

Fig. 5.
Section 20.

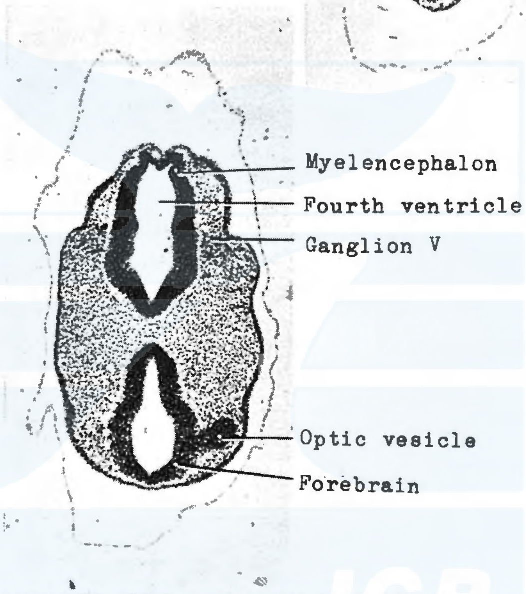

Fig. 6.
Section 31.

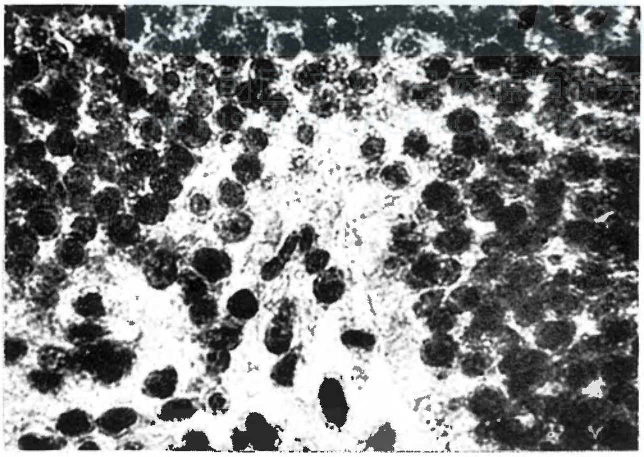

Fig. 7. Detail from section 31 showing descending neural crest in the angle between forebrain and optic vesicle.

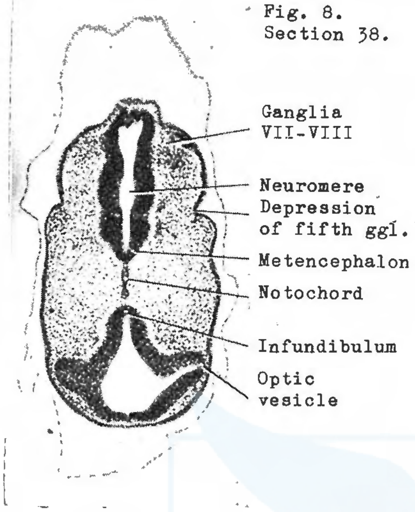

Fig. 8. Section 38.

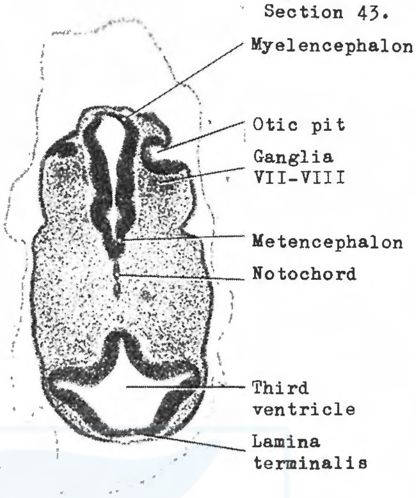

Fig. 9. Section 43.

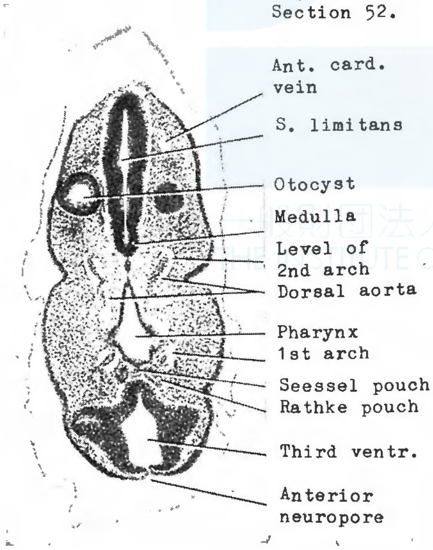

Fig. 10 Section 52.

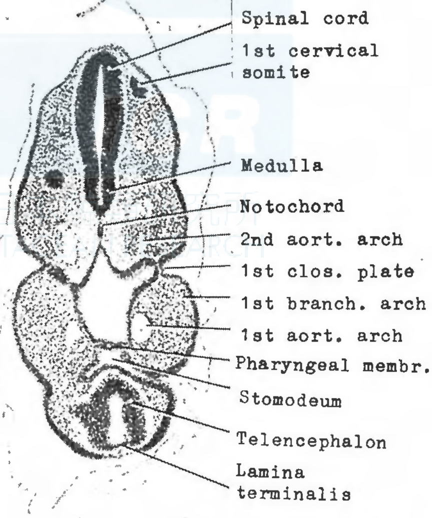

Fig. 11 Section 57.

Fig. 12.
Section 65.

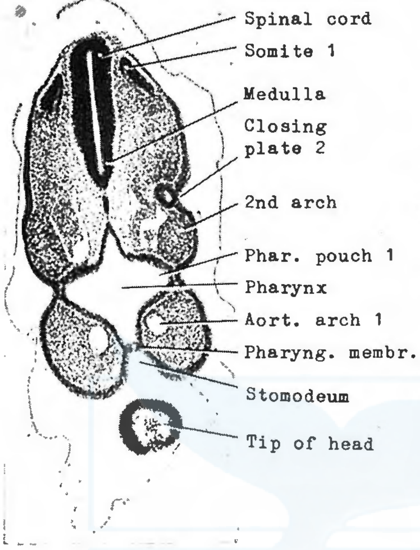

Fig. 13.
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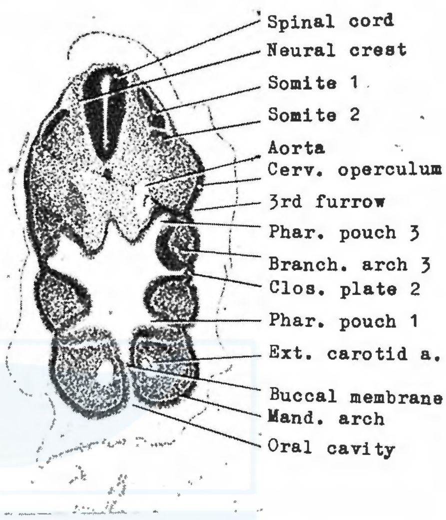


Fig. 14.
Section 96.

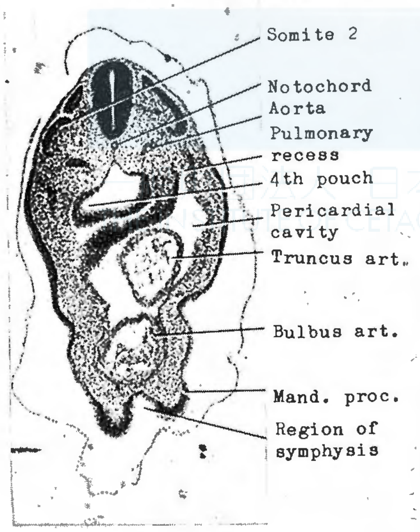


Fig. 15.
Section 102.

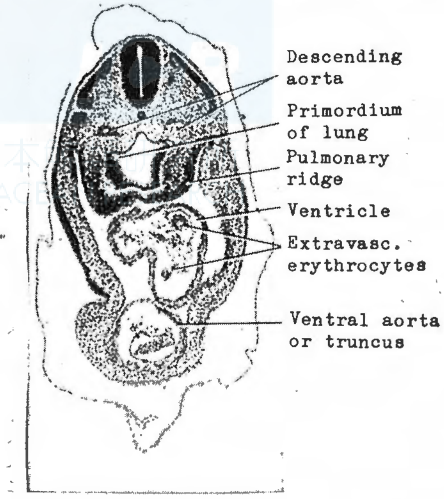


Fig. 16. (Section 106)

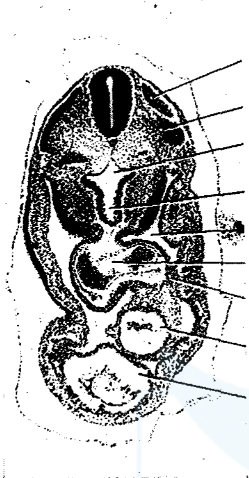


Fig. 17. (Section 126)

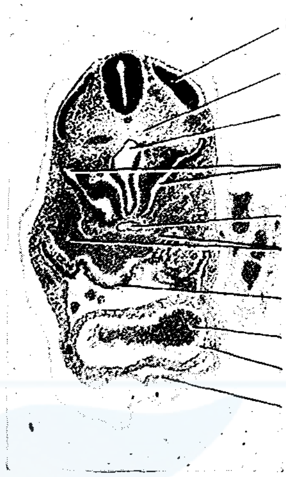


Fig. 18. (Section 142)

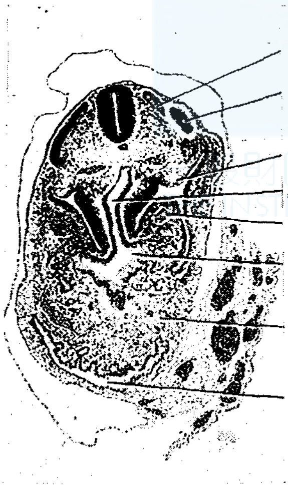


Fig. 19. (Section 168)

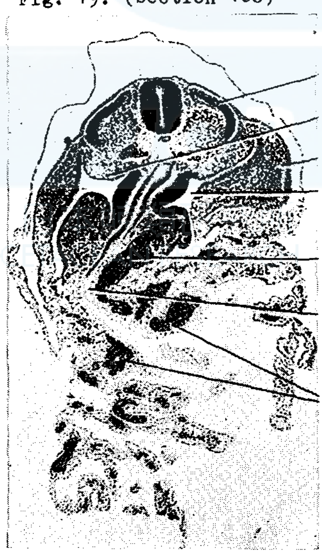
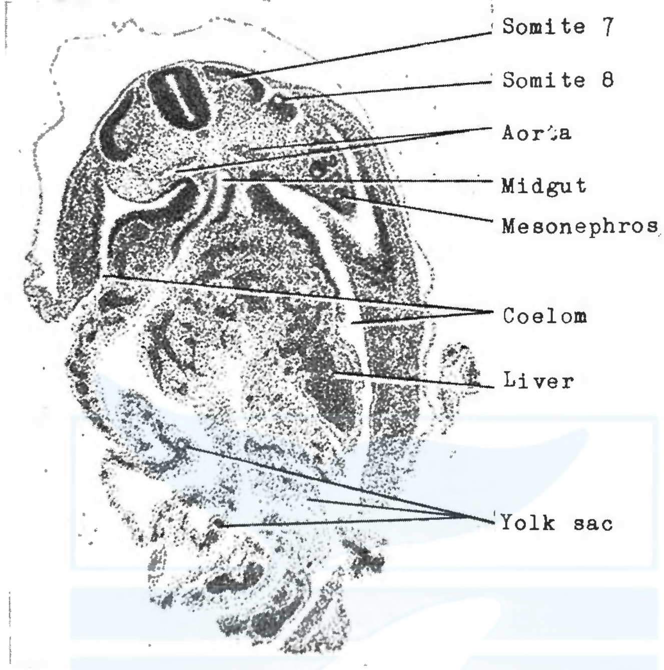


Fig. 20. (Section 186)



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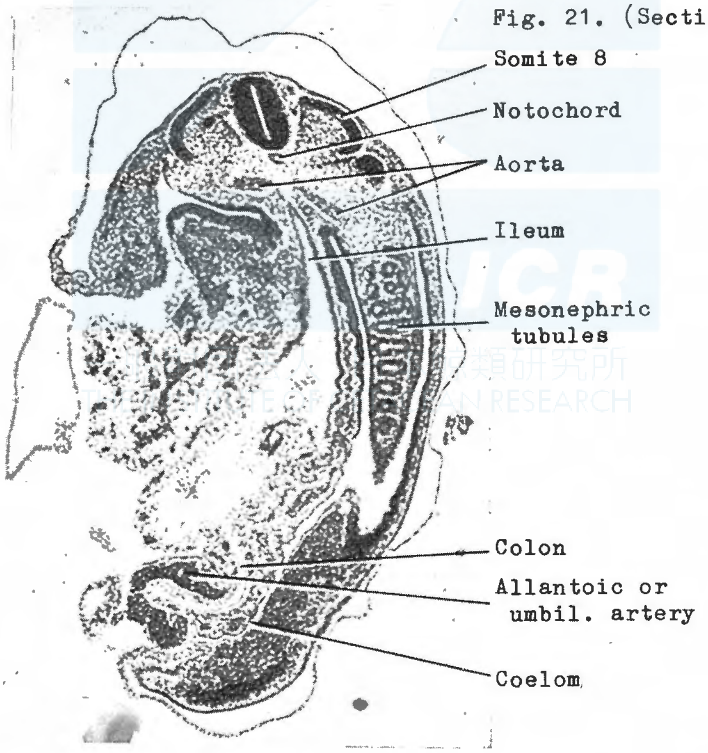

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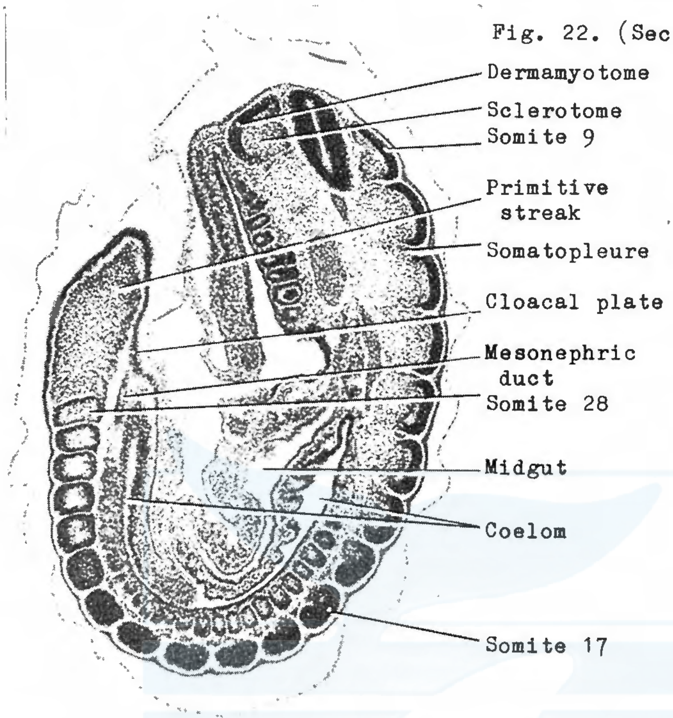
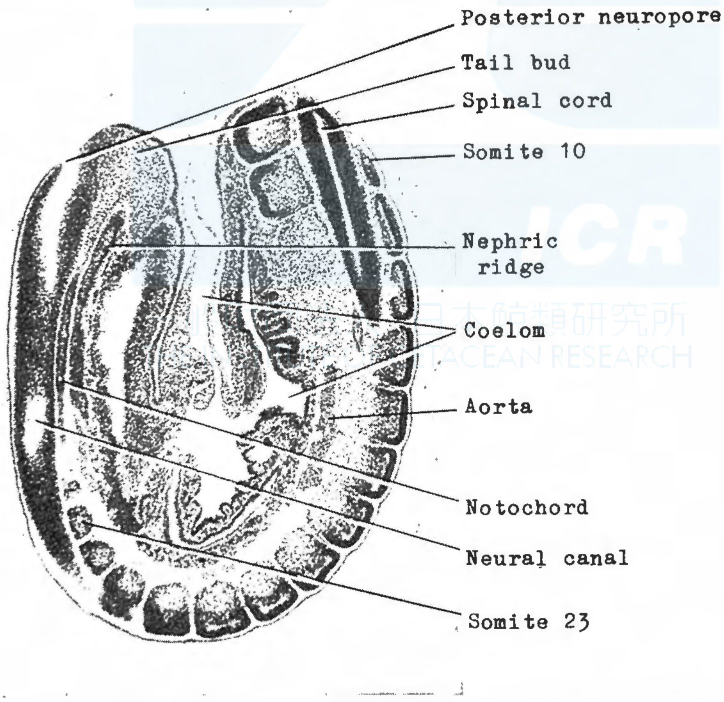


Fig. 23. (Section 220)



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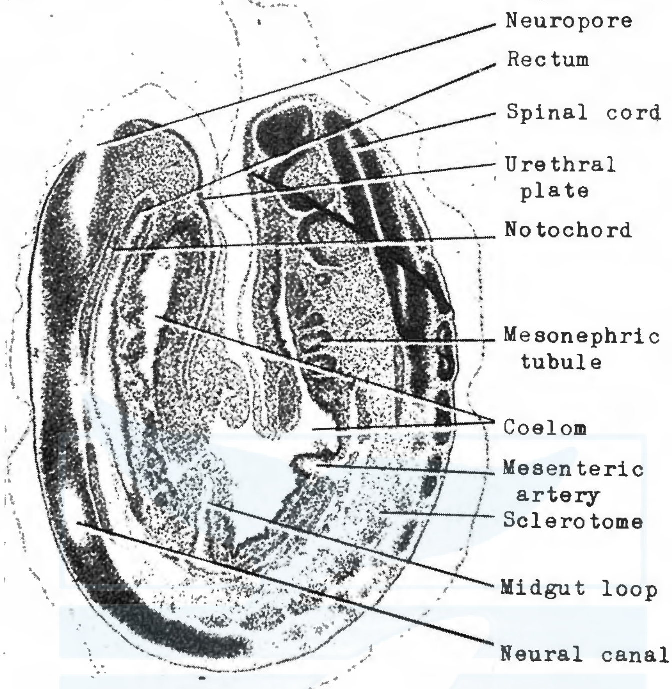

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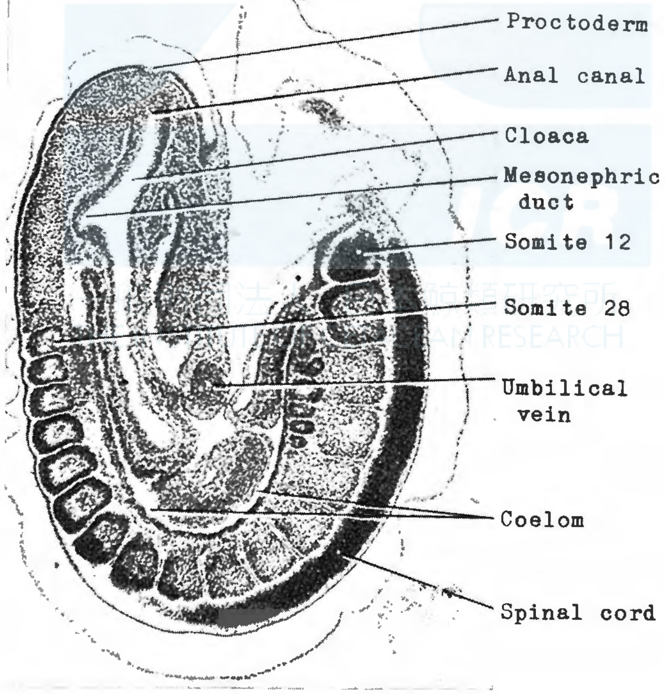

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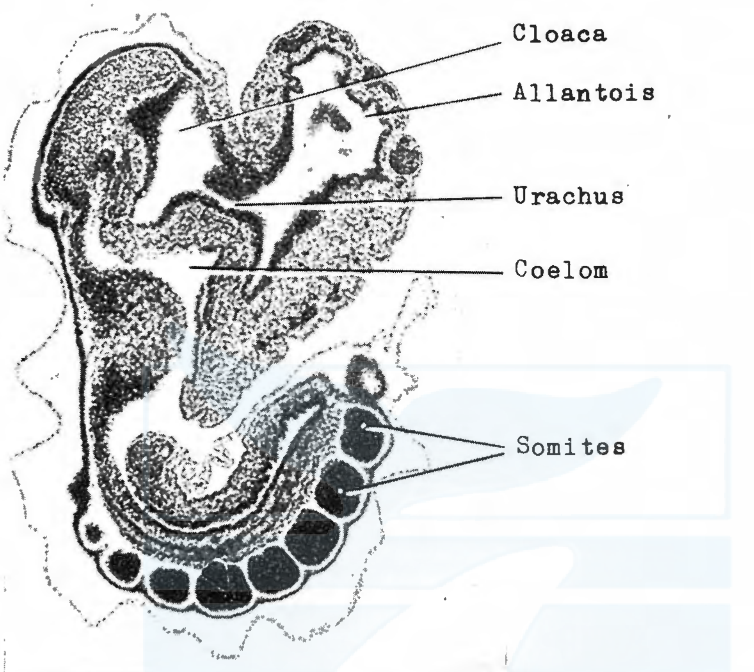

Fig. 27. (Section 275)