

NOTE ON THE PRESENCE OF THE FIFTH AORTIC ARCH IN A 6 MM. PIG EMBRYO

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THREE FIGURES

In a paper printed in 1906, F. T. Lewis, after reviewing the observations recorded by previous authors and those made by himself, came to the conclusion that "The interpretation of the postbranchial body in mammals as a fifth pouch, and of the irregular vessels in front of it as a fifth arch are morphological speculations of much interest, in favor of which the preceding observations afford no certain evidence." The same author had also made the statement in a previous article that "The irregular small arteries around the fourth entodermal pouch do not, as Zimmermann believed, form a distinct aortic arch." To this view W. A. Locy has taken exception.

In 1907, Locy summarized the observations upon the vascular elements between the fourth and sixth arches as follows: "(a) A complete arch as an offshoot of the fourth and returning to it, (human, Zimmermann); (b) a complete arch connecting the fourth and pulmonic arches, (pig, Lehmann, Locy; rat, Tandler); (c) a complete arch from the truncus arteriosus to the pulmonic arch, (human, two cases, Tandler); (e) irregular vascular elements from the fourth arch, the aortic root and the pulmonary arch, (pig, Lehmann, Lewis; rabbit, Lewis, Lehmann; rabbit, in stages of degeneration of the arch, Zimmermann); and (f) a single vessel from the distal end of the pulmonic arch with unknown ventral connection, (sheep, Tandler)." Locy then adds, in opposition to the position of Lewis: "In the light of these observations it would

appear that the vascular elements between the fourth and pulmonary arch exhibit great variability, but there are recorded a sufficient number of cases of their aggregation into a complete vessel to justify the assumption that there is a fifth aortic arch in mammals, as in other vertebrates."

In looking over the Princeton series no. 126 of a 6 mm. pig, it seemed to me that there was present a fifth aortic arch on both sides of the embryo. In order to confirm this opinion, at the suggestion of Prof. C. F. W. McClure, a wax reconstruction was made, and such was clearly seen to be the case on the right side at least. As shown in fig. 1,¹ the first arch has already undergone considerable degeneration, while the second has almost entirely disappeared. The third, fourth and pulmonary arches are quite normal; the fourth is the largest, and the pulmonary has begun to give off the pulmonary artery. On the right side of the embryo there is a fifth arch which arises independently and connects with the fourth arch shortly before the latter enters the dorsal aorta.

This arch arises almost midway between the fourth and the sixth arches, there being a broad connection between its base and the fourth arch. It runs obliquely for a short distance from the aortic root toward the sixth arch and then turns at right angles to enter the fourth arch; but just before doing so it is connected dorsally with the sixth arch. From the turn on it narrows gradually up to a point just before its entrance into the fourth arch where it broadens out once more; this fact together with its beaded appearance would indicate the beginning of degeneration.

In the light of the work of Evans upon the development of the aortae a very interesting interpretation can be placed upon the structure of the fifth arch as shown here. Considering the connections between the fifth arch and the fourth and the sixth arches as enclosing foramina and taking into account a third foramen that lies in the arch itself, we have at the dorsal end of the arch the remains of a capillary plexus whose vessels are of a relatively large caliber; all traces of it at the ventral end have been lost. It

¹ My thanks are due to Mr. O. F. Kampmeier who kindly made the drawing from the reconstruction, and to Mr. C. F. Sylvester for helping me with the microphotographs.

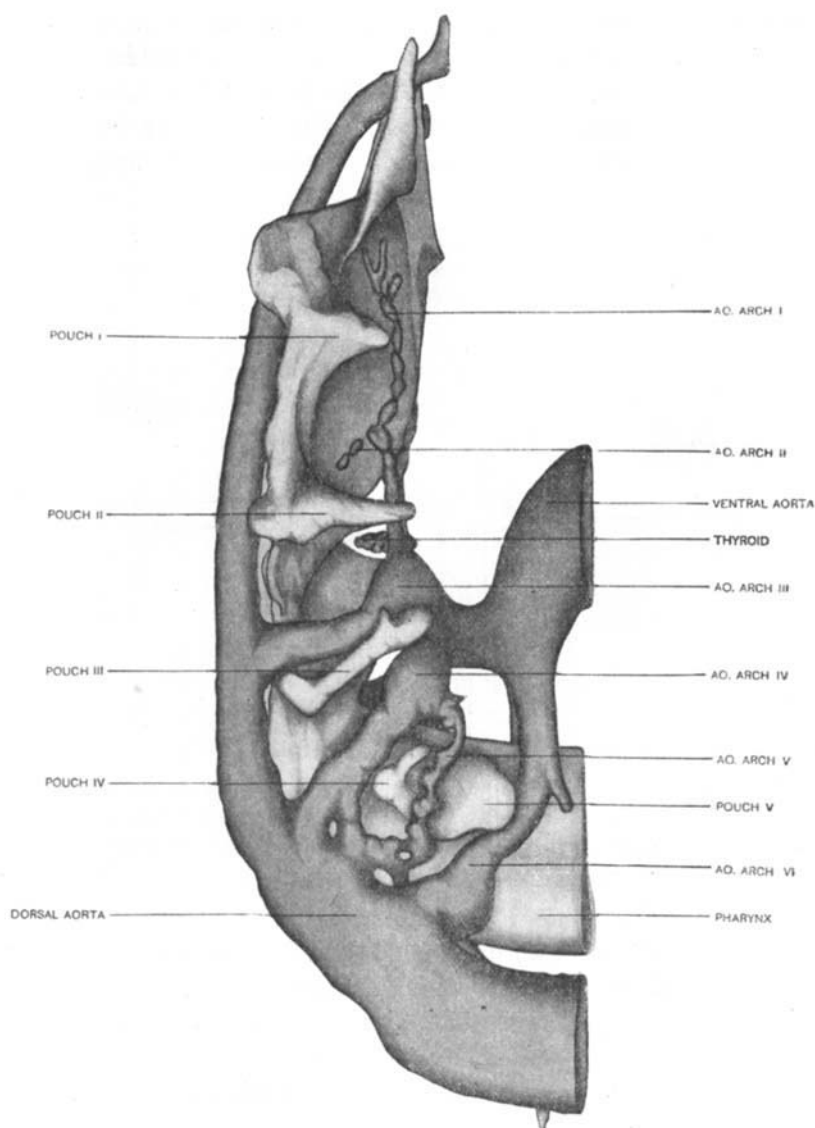


FIG. 1 Reconstruction of the pharynx and aortic arches of a 6 mm. pig embryo. Princeton Embryological Collection No. 126. Right side.

is from this plexus that the arch arose. At its dorsal end the formation of a single vessel from the plexus is not completed, although the main channel is clearly marked out. At the ventral end, on the other hand, not only has the single main vessel been established, but degeneration has already set in, this being due to the fact that most of the blood passes through the fourth arch. This

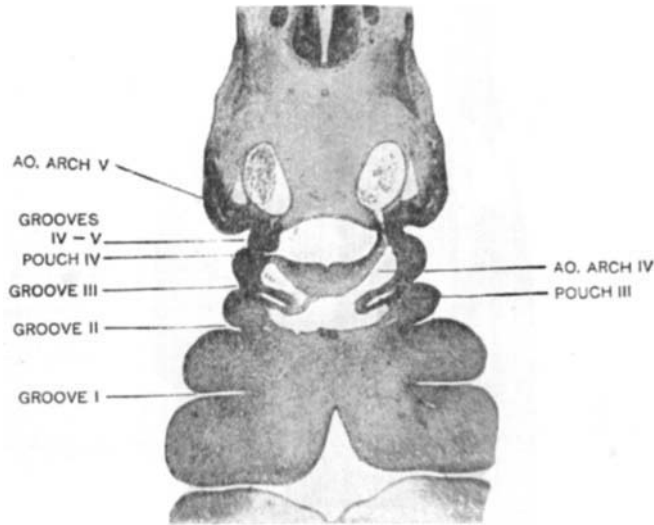


FIG. 2 A 6 mm. pig, Princeton Embryological collection, series 126, section no. 98. This section, through the region of the pharynx, shows the fourth pharyngeal pouch and the five ectodermal grooves on the right side. The fifth arch is seen in cross section just below the right dorsal aorta.

disuse of the fifth arch would naturally cause the degeneration of the ventral half of the vessel very soon after its formation, in fact probably before the dorsal half has been fully crystallized out. Moreover, there is no reason to believe that this process of crystallization would continue at the dorsal end after degeneration had once commenced below.

To my mind this affords a very clear explanation of why so many instances have been observed of irregular vascular elements lying between the fourth and the pulmonary arch and for the most

part connected with the aortic root. The embryos were probably killed after the ventral portion of the arch had degenerated, or perhaps, as was most probably the case, the plexus had disappeared at that point without having formed a single main channel. But it is to be noted that very probably the broad portion of the fifth arch at the point where it joins the fourth arch is to a

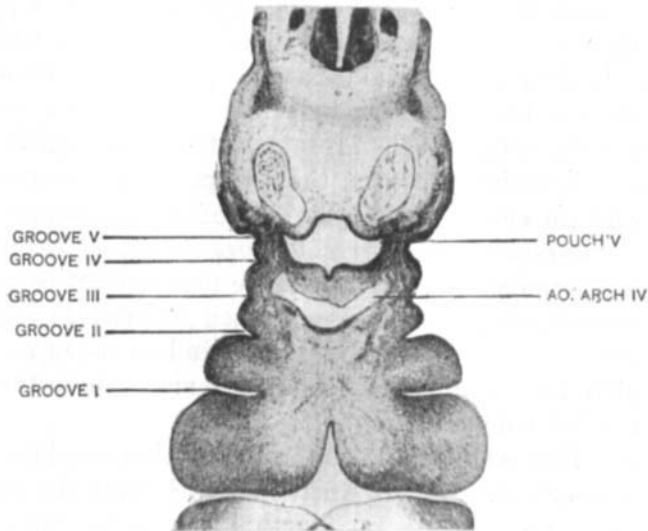


FIG. 3 A 6 mm. pig, Princeton Embryological collection series No. 126, section 102. This section shows the five ectodermal grooves more clearly than they are shown in fig. 2. The fifth pouch on the right side is seen to correspond to the fifth groove. The fifth arch is also shown here in cross section but further away from the right dorsal aorta than shown in fig. 2.

certain extent comparable to the spurs described by Coulter in the cat embryo. Its persistence would seem to indicate that whether or no a main channel is formed from the plexus there is a stimulus for the blood to flow in that direction.² On the left side of this embryo the appearance of the vascular elements resembles in general some of the cases described by Miss Lehmann, there

² In this particular case there can be no doubt that the channel formed was used as an actual blood passage, as blood corpuscles were found to be present in it.

being a narrower and shorter vessel running from the aortic root to the fourth arch, together with other small and irregular vascular remnants. Here, where in all probability a main channel was never formed, there is a spur on the fourth arch similar and corresponding to the broadened ventral end of the fifth arch on the right side.

In further support of the statement that we are dealing here with a complete fifth arch is the fact that there are five pharyngeal pouches present, between the fourth and fifth of which lies the arch. In the paper mentioned above, Miss Lehmann also described five pouches, but Lewis is inclined to doubt that the postbranchial body (fifth pouch) arose as a true pharyngeal pouch. It is true, as he points out, that the fifth pouch never comes into contact with the ectoderm, but here there is very strong evidence that it is a true pouch. On the right side of the embryo from which the reconstruction was drawn there are five distinct ectodermal grooves present, one corresponding to each pharyngeal pouch. It is to be noted that the five grooves are found on the same side as the complete fifth arch, while on the left side, where there is a smaller and less complete arch, only four ectodermal grooves are to be seen. This is shown in figs. 2 and 3, which are photographs of two transverse sections, 15 micra thick, through the region of the pharynx. Fig. 2 shows the fourth pouch on the right side in contact with the ectoderm as well as the five ectodermal grooves. Fig. 3 gives a clearer view of the five grooves and also shows the fifth pouch almost in its entirety. Other 6 mm. pig series of the Princeton collection were examined, but none of them showed either five ectodermal grooves or a complete fifth arch on either side. This one clear case, however, of the presence of a fifth ectodermal groove, together with the well known fact that the fourth pouch and the postbranchial body arise from the pharynx independently of each other, indicates that the latter was originally a true pharyngeal pouch, *i.e.*, the fifth.

It is clear that here we have a series of sections of a 6 mm. pig which is particularly advantageous. On the right side of the embryo not only is there a more complete fifth arch than has hitherto been described for the pig, but there are also five pharyngeal

pouches and five ectodermal grooves corresponding to them. The left side, on the other hand, shows an arrangement of the vascular elements and the pharyngeal pouches which resembles in general those described by previous writers. In view of this evidence the existence of a complete fifth arch in the pig can hardly be called into question any longer and, in the opinion of the writer, those vascular elements so frequently found between the fourth and the sixth arches must be interpreted as the remnants either of a fully developed or a potential fifth arch.

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