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Situs Cordis in Parabiotic Frog Larvæ.

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It is known that the situs of the heart and viscera can be experimentally reversed by turning around a portion of the archenteric roof in the open neural plate stage of development.[1] Spemann and Falkenberg[2] have also shown that if salamander eggs are divided into 2 by a hair loop, the sinistral larvae which result all have normal situs while some of the dextral ones have *situs inversus*. Spontaneous double monsters in man as well as in some of the lower vertebrates occasionally show *situs inversus* of the heart and viscera of the right member of the pair (A component).[3] Politzer,[4] however, reports 2 cases of spontaneous twinning in Salamandra in which *situs inversus* occurred in the left member (B component). Swett[5] has also reported *situs inversus viscerum* in the left member of double trout. Moreover, in some spontaneous dicephalus monsters of *Rana sylvatica* discovered some years ago, the hearts of the left individuals were in inverse situs, while the right hearts were of normal asymmetry.

This paper is a preliminary report of an attempt to study the question further. Parabiotic twins were made from *Rana pipiens* embryos in open neural plate stage by removing the ectoderm, and in some cases the mesoderm as well, from a portion of the lateral body wall and holding the embryos together until healing took place. Fifty-eight pairs were available for study at the feeding stage.

Although in most cases nothing but the ectoderm had been removed in making the twins, and the 2 hearts lay in a common pericardium with the *sinus venosus* of each animal communicating with that of the other, the right ventricle was larger than the left in 36 cases. The ventricles were the same size in 6, and the left ventricle larger in only 11 cases.

Four pairs had a single heart, evidently formed by the fusion of the 2 anlagen. The right heart was of normal asymmetry in all the other cases. The asymmetry of the left heart could be determined

1 Pressler, K., *Arch. f. Entw.-Mech.*, 1911, **32**, 1.

2 Spemann, H., and Falkenberg, *Arch. f. Entw.-Mech.*, 1919, **45**, 371.

3 Morrill, C. V., *Anat. Rec.*, 1919, **16**, 265.

4 Politzer, G., *Arch. f. Entw.-Mech.*, 1926, **108**, 417.

5 Swett, F. H., *Anat. Rec.*, 1921, **22**, 183.

with certainty in only 43 cases. In 20 of these, in which the medial sides of the 2 heads were fused and the medial gills consequently completely absent, the left heart was in normal situs. The heads were farther apart in 23 cases so that gills were present on the medial sides. In 14 pairs the left heart was also in normal situs, but in 9 pairs *situs inversus cordis* was present in the left individual (Fig. 1). The anterior extent of fusion on the medial side has, therefore, an important bearing on the asymmetry of the heart.

FIG. 1.
Cross section of parabiotic twin showing mirror imaging of the 2 hearts. The thin walled atria have been indicated by dotted lines. Below them lie the ventricles with trabeculæ carneæ. The conus arteriosus of each heart is the round chamber on the lateral side of the atrium and ventricle. Note that the right heart is in normal situs, while the left is in situs inversus.

The 2 livers were usually fused together and usually lay in the right side of the common body cavity. Two gall bladders were almost always present in the fused liver. In one case in which the livers were not fused, *situs inversus viscerum* as well as *situs inversus cordis* was present in the left individual. The double stomach and intestine of all the other cases were in normal situs with respect to the common liver.

Summary, The right heart of parabiotic twins of frog larvae is usually larger than the left. If medial gills are absent, both hearts are of normal asymmetry. If medial gills are present, the left heart is of inverse situs in some cases. The situs of the viscera is as a rule not affected by parabiosis.