

innervated by nerves anterior to the lumbosacral plexus, but in 3 cases they received, in addition, a dorsal ramus from the 15th spinal nerve.

Whether functional or not, the grafted limbs received extensive innervations from the spinal nerves. In order to reach the limbs the nerves traversed abnormal pathways through the body musculature. When limbs were grafted high on the side of the body they became innervated by enlarged dorsal rami which grew laterally or dorso-laterally to reach them. Ventrally situated grafts were supplied by ventral rami which followed their normal paths until they reached the level of the limb and then turned abruptly laterally to enter them. Since the spinal nerves were already laid down at the time the operations were performed, it is probable that the ends of the nerves were cut, and that they regenerated into the graft as it differentiated.

The 2 chief nerves entering the thigh of a normal hind-limb are the cruralis and ischiadicus. By means of graphic reconstructions of the plexuses to grafted limbs both these nerves could be identified in their usual positions. This was true even for limbs whose antero-posterior axes had been reversed. At the base of the grafts, as in normal limbs, the ischiadicus communicated with the cruralis.

Cell counts of the spinal ganglia showed that there is extensive sensory hypoplasia following the removal of the hind-limb, and extensive hyperplasia in the ganglia supplying a supernumerary limb.

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Experiments on the Determination and Development of the Pronephros of *Amblystoma Punctatum*.

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This investigation deals with two problems; first the time at which determination of the pronephros occurs and second, the question of the transplantability of this organ and its relation to the various problems of development and function.

Prospective pronephric mesoderm from embryos of early stages was transplanted to the flank region of animals in the early tail bud stages. When this method is used, the capacity to form pronephric tubules is determined at the stage of widely open neural folds. (stage 15). The tubular pattern of 2 nephrostomal canals and a

common tubule is also determined at this stage. Although, according to this type of transplantation, the determination of tubular pattern occurs in embryos of stage 15, the pronephros acquires its complete determination gradually during the period from stage 15 to the time of the closure of the neural folds, since heterotopic grafts from embryos in these stages never develop completely normal organs. Transplants of partially determined prospective pronephric tissue develop into normal structures in the orthotopic position while they do not do so in heterotopic positions on the flank. This shows that determinative influences are still present in the normal surroundings of embryos in the early tail bud stages.

Tissue from embryos in the late gastrula stage (stage 12) and older has been transplanted into the body cavity of older *Amblystoma* larvae according to the technique described by Holtfreter.¹ Preliminary examination of this material indicates that, according to this method, determination has been acquired by stage 12. If this is substantiated a marked discrepancy will exist between the time at which the pronephros appears to be determined according to the 2 different tests, since, from the standpoint of development there is a wide gap between the gastrula and neurula stages. Experiments are in progress to determine the cause of this difference in the reaction of the grafts to the new environment.

In the experiments on the development of transplanted pronephroi, embryos from the stage just after the closure of the neural folds (stage 19) to that in which the tail bud is beginning (stage 25) were used. The pronephros of one side was transplanted from its normal location to the region ventral to somites 5 to 9. The development of these heterotopic grafts varies with their position in the host. Grafts placed ventral to somites 5 and 6 are usually morphologically normal and may develop into physiologically normal organs which can take over the entire pronephric function of the larva after the removal of the normal organ of the opposite side. In such cases the transplants show hypertrophy comparable to that occurring in the remaining organ after unilateral pronephrectomy.²

Grafts placed ventral to somites 7, 8, and 9 show a retarded development in early stages. They may become morphologically complete but all parts are much smaller than normal in animals which have reached the stage at which feeding begins (stage 46). These

¹ Holtfreter, J., *Roux's Archiv. f. Entwickl. mech. d. Organ*, Bd., 1929, **117**, 421.

² Howland, R., *Proc. Nat. Acad. Sci.*, 1916, **2**, 231; *J. Exp. Zool.*, 1921, **32**, 355.

organs are incapable of taking over the complete pronephric function of the animal although an enlargement of the tubules after removal of the normal pronephros indicates a response to the increased functional demand.

The presence of the graft in the posterior position results in the formation of glomerular capillaries by the host in the region of the transplanted nephrostomes.

When prospective pronephric tissue is placed just posterior to the normal pronephric region the tissues forming the common tubule of the transplant and the normal pronephros unite to form a single structure but the nephrostomal canals develop independently. In such grafts a continuous glomerulus is found extending from the region of the anterior nephrostome of the normal pronephros to the posterior funnel of the graft. The surface of this structure is markedly increased although the total volume appears little greater than normal, as the glomerulus is longer in the anterior-posterior axis but shorter in the lateral direction.

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Muscle Response to Foreign Innervation.

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Whether a muscle with foreign innervation will respond by contraction to any impulse reaching it or only to specific impulses which are characteristic for that muscle, has not yet been finally determined. To study the behavior of muscles with foreign innervation, anastomoses have been made between the individual nerve trunks of the brachial and lumbar plexuses in albino rats. The following anastomoses have been successfully obtained: sciatic to median and ulnar, sciatic to the radial, median and ulnar to the femoral, and the median with the ulnar to the sciatic.

The cut ends of the nerves were approximated and held in place by suturing with silk to the body wall. While so held the outgrowing fibers of the regenerating proximal nerve trunk grew along the distal trunk to the new muscle groups. A high percentage of the proximal nerve trunks showed evidence of regeneration and in about 50% of the 60 animals operated upon the nerves reached the muscle groups toward which they were directed.