11. Transplantation Experiments in Planaria gonocephala, I.

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The experiments were carried out for the last three years in the following categories: 1) transplantation of the small portions cut out in rectangular shape from different levels of the body into other regions of the same or other individuals in normal and reversed anteroposterior orientations including rotation of the portions in situ, 2) union of two large parts of the same or different regions in iso- and hetero-polar directions, and 3) homoplastic homo- and hetero-pleural reindividualizations of two halves of an animal longitudinally divided. The present and the next papers are a brief statement of some of the more important results obtained thus far.

I.

With respect to the transplantation of small portions into other regions two possible methods of fusion with the host were found, namely in one case the dorsal and the ventral epithelia of the graft established a right connection with the corresponding epithelia of the host. In the other case the pieces were implanted too shallow or too deep and both dorsal and ventral epithelia of the graft were fused with only the dorsal or the ventral epithelium of the host. In both cases new tissue always appeared more or less at the junction around the transplanted portion, with the result that a deep invagination in the first case and a vertical outgrowth from the general surface of the host in the second case were produced. The same outgrowth was invariably produced in the dorsoventrally inverted implantation of the pieces.

a) Throughout the entire series of experiments of this category the head portions cut out from the anterior end of the animal including the ocular spots and a pair of ganglia exhibited the strongest power of head production irrespective of place and orientation. In the prepharyngeal region, for example, it could easily replace the head of the host when the latter was cut off at the anterior level of the transplanted portion or produce the heteropolar head when the cut was made at the posterior level of the same portion (text-fig. 1). The same held true in the transplantation into the postpharyngeal region, with an additional production of the pharynx at a certain distance from the graft (text-fig. 2 and pl. fig. 2).

If, on the other hand, a planarian having the head portion in the
postpharyngeal region remained intact, new tissue developed both anteriorly and posteriorly from the level where the implanted portion found its place and two pharynges made their appearance, one being anterior and the other posterior to the level between the new and the old tissue of the host (text-fig. 3). Of course, the anterior pharynx takes a direction reversed to that of the host-body.

b) When a small rectangular portion was rotated anteroposteriorly at the median prepharyngeal level and the anterior part was removed, the head was always regenerated in spite of rotation of the tissue of at least the median portion (pl. fig. 1). If the prepharyngeal portion was brought into the postpharyngeal region in reversed direction and the host was cut at the anterior level of the transplanted piece, the head always developed from the anterior (original posterior of the graft) free surface of the posterior part. If the same portion was placed in the normal orientation and the host’s tail was removed at the posterior level of the graft, the head was still produced from the posterior (original posterior of the graft) surface of the anterior part and a new pharynx made its appearance between new and old tissues in reversed direction.

It may therefore be concluded that the prepharyngeal pieces are also possessed of the power as head pieces to develop the head in the postpharyngeal region in any orientation. Moreover, if a planarian bearing the prepharyngeal portion in the postpharyngeal region remained intact without subsequent cut, new tissue prolifies from the transplanted level all around exactly as in the case of the head graft, with the resulting production of two pharynges, one being anterior and the other posterior to the transplanted prepharyngeal portion which in itself at least contains no ganglionic elements (pl. fig. 3). Santos (1929 and '31) lays great stress on the rôle of the ganglionic portion for the reorganization of host tissue and induction of development of the new pharynx in the postpharyngeal region, while in the cases of the present experiments it is shown that the same induction is also possible by the implantation of the non-ganglionic prepharyngeal tissue.

c) The last mentioned fact was further evidenced by the subsequent grafting experiments of the preocular pieces or those portions cut from the auricular lobes—both contained no ganglionic elements—into the postpharyngeal region. They behaved exactly like the head portion and induced development of the new pharynx in the postpharyngeal region (pl. fig. 4).

d) Likewise, if the latter portions taken from the level of natural fission were grafted into the prepharyngeal region in any orientation a head was generally resulted from the anterior and a tail from the posterior cut-surface of the graft and a new pharynx made its appear-
ance in the grafted tissue itself (text-fig. 5). Nearly the same results were obtained when the postpharyngeal pieces were transplanted into the same regions of other individuals.

e) Further, if the small portion which was taken out of the posterior extremity was brought to the middle of the prepharyngeal region and the host’s head was removed at the anterior level of the graft, a tail was always produced from the anterior cut-surface (pl. fig. 5). In this last case new tissue was produced between the host and the graft in which appeared a pharynx in reversed direction.

**Explanation of text figures.**

1. Implantation of head piece into prepharyngeal region in reversed anteroposterior orientation. After union was completed posterior part of the host was removed. Head developed posteriorly, without formation of pharynx.

2. Implantation of head piece into postpharyngeal region in reversed anteroposterior orientation. After complete union host’s tail was removed by a cut at the level just posterior to the graft. Head developed posteriorly, with formation of new pharynx.

3. The same as before. But in this case host’s tail remained intact. The graft which first invaginated ventrally was brought to the host-plane by two side cuts. Two pharynges appeared in opposite polar orientation.

4. The same as before, the only differences from that case being that the graft was placed in normal orientation and anterior part of the host was subsequently cut off at the level immediately behind the pharynx. From anterior cut-surface of the posterior part, tail instead of head was produced so that the specimen became propellor-shaped with tail on either side.

5. Implantation of postpharyngeal piece into prepharyngeal region in reversed anteroposterior orientation. After complete union host’s head was removed by a cut at the level just anterior to the graft. From the original posterior end of the graft tail regenerated and reversed pharynx appeared.

From the foregoing data of experiments the following two facts emerge. First, when a small portion of tissue is taken from its original situation and put into other regions of the body there is always proliferation of new tissue around the graft. Secondly, if this transplantation takes place between the pre- and post- pharyngeal regions there appears always the pharynx which is made up partly of the new
regenerated tissue but partly of the old tissue of the postpharyngeal component. It is irrelevant to the problem at hand whether the transplanted portion finds its direction isopolar or heteropolar with respect to the axis of the host.

**Explanation of Plate.**

Fig. 1. Rotation of small rectangular portion in the middle of prepharyngeal region. After reunion of the piece, anterior part of the host was removed, with the resulting production of new head.

Fig. 2. Implantation of head piece into postpharyngeal region in normal anteroposterior orientation. In this case host's tail was removed by the cut at the level just posterior to the graft. From posterior free surface head with 4 eyes appeared. Pharynx (ph) developed some distance behind in reversed orientation.

Fig. 3. Implantation of prepharyngeal piece into postpharyngeal region in reversed anteroposterior orientation. Union complete. Two pharynges appeared one anterior (ph a) and one posterior (ph p) to the graft (gr) in opposite polar orientation.

Fig. 4. Implantation of preocular piece into postpharyngeal region of the same individual. Host's tail was removed at the grafted level. Small head with little eyes resulted and pharynx of reversed orientation appeared between new and old tissues.

Fig. 5. Implantation of tail piece into prepharyngeal region in normal anteroposterior orientation. After union was completed host's head was removed at the grafted level. On the left side head regenerated from host's tissue while tail regenerated on other side from graft's tissue. Right anterior cut-surface of the host was closed. Between host and graft reversed pharynx (ph) appeared.