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Sex Development in Parabiotic Chains of the California Newt.*

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In a previous communication¹ it has been shown that in *parabiotic twins* of *Triturus torosus* the heterosexual combinations give evidence of an intense antagonism resulting in the decrease of the number of germ cells in both testes and ovaries. In some cases the ovaries were found completely sterile and often they showed a tendency toward sex reversal (*free-martin effect*).

In an attempt to modify this experiment in its quantitative component, *parabiotic chains* have been made by grafting one embryo with its front end on to the tail bud of another embryo. Similar chains of 3 and 4 individuals lived up to 2 months, though only chains of 2 developed and metamorphosed at the same pace as the single controls. About 50 of these chains have been raised. A few, now over one year old, are still alive. Over half of them have been cut in serial sections.

There is some variation in the mode of union of these chains. As a rule the first animal ends at the pelvic region, where the second one is broadly attached with the midbrain region of its head. The spinal cord of the first and the brain of the second animal are grown together in most cases. Despite this very intimate fusion the larger bloodvessels have never been found connected. The two circulatory systems are linked through capillaries only.

The sexes, as expected, are found in 4 combinations. (1) In case both animals are females, the first one has without exception, the better developed ovaries, with larger ovocytes. (2) If both are males, a corresponding difference in size is even more pronounced. One may suspect this difference as being due to better nutritional conditions in the first animal. However, the fat bodies of the second one are well developed, in fact often oversized, while in starved controls they become reduced sooner than the gonads. It is more likely that the slow gonadal development of the second animal is a consequence of the absence of the hypophysis, which, at the time of operation has been partly or completely removed, together with the

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¹ Witschi, E., and McCurdy, H. M., *PROC. SOC. EXP. BIOL. AND MED.*, 1929, xxvi, 655.

anterior end of the head. Insufficiency of the hypophyseal hormones is clearly expressed in the light color of most of the posterior animals. That they are not entirely lacking is evidenced, on the other hand, by the growth of the thyroid and the normal progress of metamorphosis. Control experiments show that hypophysectomy in 4 month old larvae results in a distinct underdevelopment of the testes after only a few months, while the ovaries are little or not at all retarded during the first year.

(3) Chains composed of an anterior male and a posterior female, show a nearly normal condition of the testes while the ovaries are always very rudimentary and in most cases completely sterile.

(4) If, on the contrary, the first animal is a female and the second one a male, one finds more varied results. In most cases the female has well developed ovaries with large ovocytes while the testes of the male are rudimentary. In a few cases both ovaries and testes are poorly developed, duplicating thus the status generally found in the parabiotic twins. In one case the testes of the hind animal are much stronger developed than the nearly sterile ovaries of its frontal parabiont.

It is evident that the sexual antagonism observed in male-female parabiosis of the newt *Triturus torosus* as a rule attains a lesser expression if the animals are arranged in chains than if grafted side by side like Siamese twins. This difference is largely due to the slower development of the sex glands of the posterior member of the chains, but partly also to a less efficient transfusion of hormones in this combination.

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Some Observations on Ferric Chloride Addition to the Diet.

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A specific vitamin for reproduction is well recognized at the present time. This investigation forms a part of a general study of the effect on metabolism of diets lacking, or extremely deficient, in vitamin E.

Waddell and Steenbock¹ state that vitamin E may be destroyed very completely by the addition of 1% of ferric chloride to the diet.

¹ Waddell, J., and Steenbock, H., *J. Biol. Chem.*, 1928, **lxxx**, 431.