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Transformation of Testis to Ovary in Heteroplastic Parabiosis in Amblystoma.

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A study of sex reversal in heteroplastic combinations of Amblystoma has been in progress for some time, and a total of 146 pairs of *A. tigrinum—A. punctatum* have been studied, in which both partners are sexually differentiated. The advantage of heteroplastic combination lies in the more rapid development and larger size of the tigrinum member, which invariably becomes sexually dominant at a relatively early stage, regardless of its own sex. Likewise, the gonads of the punctatum member, irrespective of sex, undergo modification and reversal in varying degree. In the present paper we shall confine ourselves to an outline of the process of transformation from testis to ovary in the gonads of punctatum males joined to large tigrinum females.

In accordance with the laws of chance combination, 4 sex-species combinations are possible, and up to about 90 days in the experiment these occur in the expected ratio, as follows: ♂♂ 20, ♂♀ 17, ♀♂ 21, ♀♀ 23.* From this it is apparent that such factors as early mortality, or atypical sex ratios in the eggs used, can be excluded as influencing the result. And since the mortality subsequent to sex differentiation was low, and moreover included in the data, this factor, difficult to rule out in past experiments, is here completely eliminated from the result.

In the later stages of the experiment the expected ratio is greatly modified due to complete reversal of sex in the punctatum member of many pairs of the ♀♂ group. This is accompanied by a corresponding excess of ♀♀ pairs: ♂♂ 20, ♂♀ 13, ♀♂ 3, ♀♀ 29. These data, coupled with the histological evidence to be summarized, force us to conclude that virtually all punctatum males united to large tigrinum females undergo reversal of sex, which is, in many instances, already complete. The histological evidence may be summed up in the following principal points:

(1) Histological transformation of testis to ovary is seen in the gonads of almost all punctatum members of ♀♂ pairs prior to

* In all cases in this paper the large sex symbol represents the tigrinum member, the smaller the punctatum.

90 days, beyond which few such pairs can be found. The only exceptions are found in a few quite young pairs.

(2) Transformation of testis to ovary may occur by "direct differentiation," in which indifferent gonads, zygotically testes, differentiate as ovaries in large parts of their extent, with subsequent reduction of the testicular portions; or, by delayed reversal in well developed testes, in which the rudimentary cortical component develops rapidly, while the medulla is removed by retrogressive changes involving cavity formation in the rete apparatus. All older ♀ ♂ pairs are conspicuous examples of this latter type.

(3) The occurrence in the ♀ ♀ group, of cases in which the rudimentary or atypical structure of the punctatum "ovary" is best explained by regarding them as completely transformed testes; an assumption required by the statistical evidence.

The demonstration of reversal of testis to ovary in this material agrees in histological details with cases described by Humphrey,[1] following orthotopic implantation of the gonad preprimordium, and Burns,[2] in homoplastic pairs of *A. tigrinum;* which have been discredited by Witschi.[3] It also parallels in its earlier aspects, an extensive new series by Humphrey.[4] In a recent article Witschi[5] refers to some *A. tigrinum—A. maculatum* (punctatum) pairs, as yet undescribed, in which in ♀ ♂ pairs "the maculatum male comes partly under the dominance of the tigrinum female . . . . to the extent that an ovarial cortex is permitted to develop . . ." This statement is entirely inadequate to describe the degree of transformation found by us, possibly because that writer has thus far encountered only the earlier stages of the process.

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[1] Humphrey, R. R., *J. Exp. Zool.*, 1929, **53**, 171.

[2] Burns, R. K., Jr., *J. Exp. Zool.*, 1931, **60**, 339.

[3] Witschi, E., *J. Exp. Zool.*, 1933, **65**, 215.

[4] Humphrey, R. R., *Anat. Rec.*, 1935, in press.

[5] Witschi, E., *Biol. Rev.*, 1934, **9**, 460.