GONADAL DEVELOPMENT AND SOCIAL CONTROL OF SEX INVERSION IN AMPHIPRION FRENATUS (BREVOORT)

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Introduction

Anemonefish of the genus Amphiprion are supposed to be the first example for the social control of protandrous sex inversion (Fricke&Fricke 1977; Ross 1978). The gonadal organization of Amphiprion differs from other known protandrous species by the coexistence of both heterologous germinal tissues during the primary sex phase (Reinboth 1988).

Using light- and electron microscopic criteria we investigated the gonadal and urinary bladder development and the transformation of reproductive organs during sex inversion under laboratory-conditons in Amphiprion frenatus. Restriction of social contact either to visual or to chemical cues (by permanent exchange of rearing water) showed, that social control of sex is transmitted by chemical cues (Stahlschmidt&Reinboth,1988).

Results and Discussion

Primary germ cells as well as the urinary bladder originate from the postanal entoderm. The caudal mesenchyme gives rise to somatic gonadal cells. During the entire growth-period of the early gonad mesenchymal cells migrate into the gonadal anlage and finally all individuals develop an immature ovary.

The bilobed gonads of juvenile fish are located on both sides of the unpaired urinary bladder. The wall of the urinary bladder of juveniles is built up by an outer connective tissue, a muscular layer, an inner connective tissue and an isoprismatic epithelium.

A direct development to functional female takes place, when a juvenile succeeds in taking up the $\alpha-$ position in a group. In adult females urinary bladder epithelium is squamous in shape. The muscular layer is weakly developed or even completely missing. $\alpha-$females induce (by pheromones ?) the differentiation of testicular tissue in lower ranking fish.

Differentiation of testicular tissue starts with the settlement of undifferentiated mesenchymal cells at the periphery of the immature ovary. Subsequently type A spermatogonia appear among the mesenchymal cells and the differentiation of testicular tissue takes place. Functional males inhibit the proliferation of testicular tissue in lower ranking fish. The inhibition of spermatogenic activity is transmitted by chemical cues. The columnar urinary bladder epithelium in β-ranking fish (male individuals) exhibits secretory activity.

Sex inversion occurs in functional males which succeed in taking up the $\alpha-$position in a group and in isolated males. The decrease of the spermatogenic stem cell population (type A spermatogonia) leads finally to the disappearance of spermatogenic tissue. When a male starts to become a female once again mesenchymal cells enter the persisting ovarian tissue. At the same time the urinary bladder transforms to a simple collagenous storage organ for the urine.

Histological data suggest, that the mesenchymal cells participating in gonadal transformation originate from subepithelial regions of the urinary bladder wall. This observation gives rise to the hypothesis that the urinary bladder may represent a kind of embryonic organ which stores mesodermal cells and enables the organism to develop on the adult stage a new gonadal tissue. The secretory activity of urinary bladder epithelium wich is specific to the male phase points to a pheromone producing function.

The experimental proof that functional females may develop directly without passing a male phase demonstrates for the first time that the protandry in Amphiprion represents a kind of facultative ambisexuality.

References

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