Fish Physiology and Biochemistry **28:** 173–174, 2003

Bi-directional sex change and its steroidogenesis in the wrasse, *Pseudolabrus sieboldi* ♂

K. Ohta[1], J.K. Sundaray[1], T. Okida[1], M. Sakai[1], T. Kitano[2], A. Yamaguchi[1], T. Takeda[1] and M. Matsuyama[1]

[1]*Department Animal and Marine Bioresource, Fac. Agriculture, Kyushu University, Fukuoka, Japan;* [2]*Department Materials and Life Sci., Grad. School of Sci. and Tech., Kumamoto University, Kumamoto, Japan*

Abstract

The protogynous wrasse, *Pseudolabrus sieboldi*, is a good model for studying the physiological mechanism of sex change in teleosts. We established a way to induce sex change bidirectionally by controlling the social conditions in captivity. This is the first report of a reversed sex change in a promiscuous species. After identifying all the steroid hormones produced in the ovarian follicles and testis, and clarifying their synthetic pathways, we examined the function of the sex steroids in the sex change of *P. sieboldi*. We concluded that the activation of 17β-HSD-III is the first step in inducing morphological and functional change from an ovary to a testis.

Introduction

The wrasse *Pseudolabrus sieboldi* is a diandric protogynous labrid fish that is distributed on rocky bottoms in shallow coastal waters off southwestern Japan. Large terminal-phase (TP) males arise from small initial-phase (IP) females. In captivity, as in nature, daily spawning between pairs of TP males and IP females occurs during the spawning season in autumn, and sex change can be induced under the appropriate social conditions. In this study, we investigated the social conditions that brought about protogynous sex change in a rearing tank, and attempted to induce the reverse sex change, from male to female, by controlling the social conditions. In addition, using this system, we examined the function of the steroids that likely regulate the sex change directly, based on the detailed steroid-biosynthesis pathways in the ovary and testis.

Materials and methods

To induce sex change as a result of social conditions, various numbers of IP females and TP males were kept separately. Before the experiment, the sex of each was confirmed by spawning or a half-gonadectomy.

Based on the synthetic pathways of steroid hormones in the ovarian follicles and testis, females were given an intraperitoneal implant of 0.5 μmol of T and 11-KT via a silicone tube and kept for 40 days, to examine the function of these steroids in the sex change.

Results

In *P. sieboldi*, natural sex change occurs during the prolonged non-spawning season. As protogynous sex change advances, the hue of the anal fin changes dramatically from yellow to red, and is a visual biomarker showing the degree of sex change. When six IP females (one fish larger than 140 mm in total length, and five fish smaller than 130 mm) were kept together, the largest fish changed into a TP male. Conversely, when seven TP males (one fish smaller than 140 mm, and the others larger than 150 mm) were kept in a tank, the smallest male changed into an IP female. Testicular development and TP body coloration were induced in all the females given T and 11-KT implants.

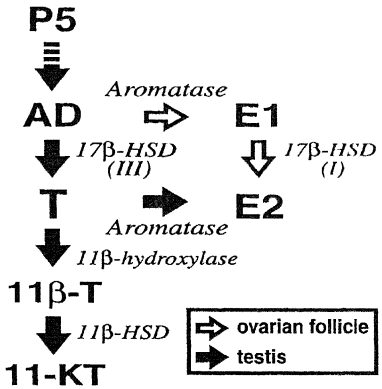

Figure 1. The shift in the steroid biosynthesis pathway from the ovary to the testis. The pathway from P5 to AD was the same in the ovary and testis. P5, pregnenolone; AD, androstenedione; T, testosterone; 11β-T, 11β-hydroxytestosterone; 11-KT, 11-ketotestosterone; E1, estrone, E2, estradiol-17β; 17β-HSD, 17β-hydroxysteroid dehydrogenase.

Discussion

In this study, we succeeded in inducing bidirectional sex change, based on the social status of fish sharing a tank. This will enable us to study the physiological control of sex change, not only from female to male, but also from male to female.

We recently clarified the complete synthesis pathways of sex steroids in the ovary and testis of *P. sieboldi*. Interestingly, T is not produced in ovarian follicles, in which 17β-HSD-I synthesizes estradiol-17β (E2) from estrone (Ohta et al. 2001). In testicular tissue, 17β-HSD-III produces T from androstenedione, and the T is metabolized into 11-KT and E2. Therefore, two types of 17β-HSD exist in the gonads of *P. sieboldi* (Figure 1). We recently found that the serum 11-KT levels increase during protogynous sex change, while the E2 levels do not change significantly (unpublished data). In this study, T and 11-KT together clearly induced the protogynous sex change. Therefore, we conclude that the activation of 17β-HSD-III, which produces T as an intermediate for 11-KT synthesis, is the first step in inducing morphological and functional change from an ovary to a testis.

References

Ohta, K., Mine, T., Yamaguchi, A. and Matsuyama, M. 2001. Steroidogenic pathway to estradiol-17β synthesis in the ovarian follicles of the protogynous wrasse, *Pseudolabrus sieboldi*. Zool. Sci. 18: 937–945.