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Mini Review

The Secret Behind the Natural Sex Reversal in Rice Field Eel *(Monopterus albus)* Remains Unknown

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Introduction

Monopterus albus, the rice field eel (Zuiew), it is under Synbranchidae family; Synbranchiformes order. It lives in the rice fields, swamps, and muddy ponds in different Asian countries. *M.albus* is a hermaphrodite and undergoes sex reversal naturally. Female are intersexes, they have both female and male sex organs with oocytes and spermatocytes in their gonads, and then they become males [1]. The sex reversal of *M.albus* normally happens after spawning when the eel grows to 35 to 45cm in length [2]. There are many researchers studied the principle of natural sex reversal in *M.albus*, one of these studies says that this process based on genetic switch-mechanism which the differentiation and maturation of female germ-cells would cease then the epigenesis of male germ-cells and the interstitial Leydig's cells started, this sexuality shifting from female to male involve the stimulation of some regulators and the mediation of biochemical components and physiological events and environmental factors might also play a role in this series of events [3]. In another study, it has been reported that *M.albus* undergoes reversal of sexfrom the female to male genetically which involve the expression of regulatory genes. The genes Sox9 and Sox17 might be responsible for regulatory genes in natural sex change, these two genes and other genes involved in sex determination, like DMRT1 [4]. It has been recorded that both cyp19a1a which was expressed in the gonads of female and male but it is higher in the ovary than testisand cyp19a1b which was expressed in all male tissues, but only in the brain and pituitary in the female, might involve in the natural sex reversal of *M.albus* via the hypothalamus-pituitary-gonadal axis, but their exact roles have not been identified [5]. Moreover, it has also been demonstrated that the gonadotropin stimulation of cyp19a1a promoter activities is down-regulated in a male-specific fashion by epigenetic changes which include DNA methylation and histone modifications, leading to chromatin remodelling. The epigenetic control of cyp19a1a gene expression might have an important role in the gonad differentiation [6]. It has been elucidated that exposure of *M. albus* to Malathion cause reduce in the ovarian growth by decreased steroidogenic capacity of ovaries. Exposure to Malathion for long time might interfere with the process of natural sex reversal of *M.albus*. The gonads exposed to Malathion were found to be filled with atretic and abnormal follicles and partially completed degenerated testicular lobules was exist [7]. It has been concluded that the granulose cells in the ovary of *M.albus* and the interstitial cells of the intersexual and male gonads are the major places for the biosynthesis of oestrogens and androgens respectively, and that the intensive development of interstitial tissue with elevation in the steroidogenic enzyme activities at the intersexual and male stages was related to the increase of androgen level. The presence of 3P-hydroxysteroid dehydrogenase (3P-HSD) positive interstitial cells in the ovary suggests that interstitial cell development might be before testicular lobule formation during natural sex reversal [8]. It has been mentioned that the fluctuation of sex steroids in the plasma levels of *M. albus* were associated with the maturation of the female and male sex tissues. In the prespawning period in female the androstenedione level increased while it decreased in the spawning period, unlike estrogen level which was higher, but the testosterone level remained same throughout the seasonal reproductive cycle in the female, during the postspawned/inactive period, the androstenedione level was the highest. In the early intersexual and mid-intersexual phases, the levels of androstenedione, testosterone, 17β-estradiol, and estrone decreased progressively in relation to the reproductive cycle. The male had a constant level of androstenedione, estrone, and 17β-estradiol. However, the level of testosterone increased as the spawning period approached. The changes in the plasma levels of sex steroids in *M. albus* related to the maturation of the female and male sex tissues and to their seasonal reproductive cycle [9]. It has been suggested that the supplement of estradiol valerate can change the sex reversal of *M. albus* [10]. Steroids produced by

the gonads at different sexual stages, but the major sex steroids showed a shift in their production during natural sex reversal was estrogensin females and when structural transformation from ovary to testis took a place, androgen production elevated noticeably. The increase in androgen production related to the development of the interstitial Leydig cells during the sex reversal [11]. However, in another study it has been recorded that the signal of initiation of sex reversal may be neuroendocrine not steroidal. In teleosts, the secretion of endogenous gonadotropin (GtH) elevates during the progression of ovarian development reaching a peak during ovulation. Because *M. albus* spawns several times in any reproductive season, it may be that the secretion of GtH has cyclicity during the reproductive season. It might be GtH cyclesor the combination of pituitary hormones triggered by Gonadotropin-releasing hormone (GnRH) initiate the natural sex reversal, and stimulate spermatogenesis and steroidogenesis [12]. In conclusion, this review is a collection of different theories established to explain the natural sex reversal, however, the exact mechanism remains unknown. This issue worth further studies to clarify the secret behind this sexual switching in *M. albus*.

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