Can we combine genetics and a two-step temperature control to move towards monosex European seabass Dicentrarchus labrax?

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CAN WE COMBINE GENETICS AND A TWO-STEP TEMPERATURE CONTROL TO MOVE TOWARDS MONOSEX EUROPEAN SEA BASS *Dicentrarchus labrax*?

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Introduction

The sea bass, *Dicentrarchus labrax*, is an important species for European mariculture, mainly in Mediterranean countries. In this species, females grow faster and reach a higher weight than males. However, most farmed fish batches show a highly male-skewed sex-ratio. The sea bass has a complex sex determination system, combining both genetic (polygenic) and environmental (temperature) influences. Low initial temperatures (<17°C) favor female sex determination. In contrast, temperature in the late post-larval phase has the opposite effect, with cold temperature favoring male differentiation and high temperature (up to 23°C) favoring female differentiation (Clota et al., 2021). However, data on the combined effects of genotype and temperature are lacking. We need to know whether there is genotype-by-environment (GxE) interaction or not, to deploy a strategy towards producing monosex female individuals for production while keeping a balanced sex-ratio for hatchery and selective breeding.

Results

Starting at 1 day and using incremental rearing periods at 16°C (31 to 244 days), followed by an increase to 21°C, we first showed that, while 31 days at 16°C led to 26% of females, increased cold exposure promoted the proportion of females, up to 46% after 74 days at 16°C. Conversely, exposure to 16°C for a period longer than 74 days progressively reduced the proportion of females, reaching a minimum of ≈ 10% after 230 days at 16°C. In a second experiment, we demonstrated that after an initial rearing of fish for 90 days at 16°C, a secondary exposure to four different temperatures (19, 21, 23, 25°C) resulted in different sex-ratios, with more females at higher temperatures (from 30% at 19°C to 49% at 25°C). Then, we examined the genotype-by-environment interaction in both periods, by genotyping fish with a 57K SNP chip, comparing 1) two groups reared at 16 or 21°C during the first 60 days and 2) four groups of fish reared at 19, 21, 23 or 25°C after 90 days at 16°C. The genetic correlation of sex tendencies between the two early temperature groups was very high (0.91 ± 0.09). In the late temperature treatments, the genetic correlations of sex tendencies between the first three temperature groups (19, 21 and 23°C) were close to unity (0.98± 0.16 to 1.00± 0.16), showing little, if any, GxE interaction. Conversely, the genetic correlations of sex tendency at 19, 21 and 23°C with sex tendency at 25°C were lower (0.82 ± 0.21 to 0.91 ± 0.21). Thus, genomic predictions of sex tendency can be reliably performed using data from any temperature treatment, provided the late temperature (after 90 dph) is not higher than 23°C

The way forward

Based on these findings, we propose a method combining temperature treatments and genomic evaluation of sex tendency to 1) identify individuals with a strong “female” genetic background, including “neomales” sex-reversed by temperature treatments, and 2) use them with adequate temperature treatments to obtain near-monosex batches.

References:

Clota F., et al., 2021. Late high temperature promotes fast growth and female differentiation in European sea bass Dicentrarchus labrax, while early photoperiod has no effect on either trait. Aquaculture Europe 2021, Funchal, Portugal, 4-7 October 2021.