

## Introduction

The rearing temperature during the early stages of the life cycle is one of the most acknowledged factors implicated in the development of malformations of gilthead seabream and European seabass (Polo et al., 1991; Sfakianakis et al., 2004; Sfakianakis et al., 2006; Georgakopoulou et al., 2007). The mechanisms causing these deformities remain unclear, but it is known that hyperthermia alters numerous functions, including metabolism, respiration, membrane function, and it is involved in dramatic changes in the expression of specific genes (Podrabsky and Somero, 2004).

The objective of this study was to identify the effect of water temperature during the early stages of gilthead sea bream and sea bass on rearing performance and deformation response in fine-tuned large scale experiments.

## Materials & Methods

The experiments were performed at the hatchery of the Institute of Aquaculture (Crete) using 12 500-L tanks. The ambient conditions were electronically controlled and adjusted to the desired levels. The rearing protocol followed the methodology described in Divanach et al (1997) and Papandroulakis et al (2001).

The experimental set up for sea bass called for using three schemes (in duplicates) with different temperatures at the autotrophic and exotrophic stages (e.g. fish starting at 15°C and going up progressively to 18°C at first feeding, from 18→21°C and from 21→18°C), and three schemes with constant temperature (15, 18 and 21°C) for both autotrophic and exotrophic stages which served as reference controls. The same set up was also used for sea bream although the temperatures were set one degree Celsius higher (16→19°C, 19→22°C, 22→19°C and three groups with constant temperatures 16, 19 and 22°C) (Table 1). The fish of all treatments were reared in the same temperature after they reached the size of approximately 16 mm total length. The experiment was finished when the fish had reached 1 g in weight. Six samplings were made for each treatment at certain developmental stages.

Analysis of deformities was performed at the end of larval rearing phase and at the juvenile stage, by means of double staining and x-rays, respectively.

## Results and Discussion

In sea bass the best growth rates were recorded in the fish which were either constantly reared in 21°C or they started at 18°C and moved to 21°C, followed by the fish which were reared in 18°C, 15→18°C and 21→18°C.

Scheme for Seabream	16°C	19°C	22°C
Scheme for Sea bass	15°C	18°C	21°C
A	Autotrophic phase	Exotrophic phase	
B		Autotrophic phase	Exotrophic phase
C		Exotrophic phase	Autotrophic phase
D	Autotrophic & exotrophic		
E		Autotrophic & exotrophic	
F			Autotrophic & exotrophic

Table 1. Experimental set up for sea bass and sea bream

The lowest growth rate was recorded at the fish which were reared constantly in 15°C. In terms of survival, the best scheme, until the fish were put in common conditions (16-18 mm), was the one that used 15°C as a starting temperature and 18°C for the exogenous feeding, while after the fish went to the common conditions the best survival was achieved by the fish which were constantly grown in 15°C.

Two severe and one light (with no effect on the external phenotype) types of skeletal deformities were detected in experimental populations of sea bass. Severe deformities consisted of the haemal lordosis and the shortened upper jaw (pugheadness), light deformity was the presence of urinary calculi. Results clearly demonstrated a significant effect of rearing temperature on all the types of skeletal deformities. Our results verified those of previous studies (Sfakianakis et al. 2006), clearly indicating that any deviation (temperature increase) from an early water temperature of 15 °C results to elevated incidence of haemal lordosis. However, we have to underline that the incidence of pugheadness was elevated at 15°C (as in the case of branchiostegal deformities, Georgakopoulou et al. 2007), thus underlining the need of future research on the combined effects of temperature and other factors important for the normal bone development (e.g. nutrition, Georgakopoulou et al. 2007). Concerning the presence of urinary calculi, this was elevated at the higher temperatures tested.

# Temperature limits for gilthead seabream and seabass

For gilthead sea bream the best growth rates were recorded in the fish which were reared at the highest temperatures (22, 19→22, 19, 16→19) while the highest survival was recorded in the fish which started at 16°C and progressively moved to 19°C and the lowest in the fish that started at 22°C and moved down to 19°C.

In gilthead sea bream, two severe and five light (with no effect on the external phenotype) types of skeletal deformities were detected. Severe deformities consisted of the inside folding of the gill-cover and of haemal lordosis. Results clearly demonstrated a significant effect of rearing temperature on gill-cover deformities, but not on lordosis. Interestingly, gill-cover deformities were proven to develop up to 12 mm TL, while in the next stages their incidence was significantly decreased (probably due to a higher mortality of the affected fish).

Current results therefore recommend the range of 19-22°C (especially during the feeding larval phase) as being safe temperature limits for early development of sea bream.

## References

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