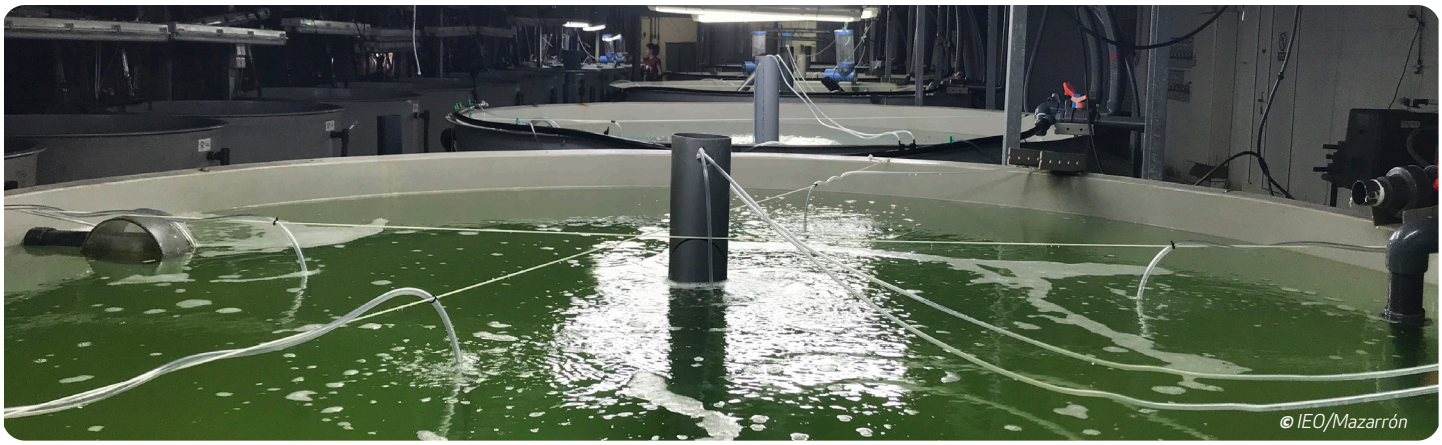
CRITICAL THERMAL LIMITS OF ATLANTIC BLUEFIN TUNA LARVAE



SUMMARY

Critical thermal limit studies in aquaculture are generally conducted with adult fish to measure their capacity to survive extreme temperatures, however, early life stages are generally more sensitive. In this study, the critical upper and lower thermal limits of Atlantic bluefin tuna (*Thunnus thynnus*) larval stages were estimated and compared with those for egg and adult life stages. Bluefin tuna is one of the world's most valuable and endangered fish species. Many challenges remain for farming this species, with much yet to be discovered about its biological life cycle. This research demonstrates that bluefin tuna larvae were more sensitive to extreme temperatures than adults, and larvae from other species. By understanding these critical thermal limits, bluefin tuna farmers can improve fish health and welfare as well as anticipate the potential impacts of extreme events (e.g. heat waves), improving the resilience of the aquaculture industry in a changing climate.

KNOWLEDGE NEED

Atlantic bluefin tuna farming is working towards a sustainable production of this endangered and valuable fish species in closed-cycle systems. Despite some European success in recent years, a lack of knowledge of the bluefin tuna biological lifecycle continues to pose challenges for the production of fingerlings in commercial quantities. While some information is available on the species' thermal preference in the wild, there is a gap in knowledge on critical thermal limits. This is especially true for early life stages, such as larvae, which may have a particularly narrow range in tolerable temperatures when compared to later stages in which regulation of internal body temperature (i.e. endothermy) is well developed. Moreover, previous studies on thermal limits for marine and freshwater fish larvae applied a wide range of methodologies, making comparisons across taxa difficult. Therefore, there is a need for more robust estimates of thermal limits of sensitive stages in Atlantic bluefin tuna to support better predictability during extreme events such as heatwaves, and to help improve output and cost control during early larval stages of the lifecycle.

POTENTIAL IMPACT

- Improvement of output and cost control for Atlantic bluefin tuna farmers during early larval stages of the lifecycle.
- Improved predictability during extreme events (e.g. heat waves), improving the resilience of the Atlantic bluefin tuna industry in a changing climate.
- Improved understanding of the sensitivity of different life-stages of Atlantic bluefin tuna (and perhaps other marine fish species also) to global warming.
- Improved welfare for Atlantic bluefin tuna.

EATiP - Strategic Research and Innovation Agenda (SRIA) Thematic Area 3 - Managing the Biological Lifecycle; Goal 1 and 4, Thematic Area 7 - Aquatic Animal Health and Welfare; Goal 4. To see the full list and descriptions of the thematic areas and goals, please visit: **eatip.eu/?page_id=46**

UNDERLYING SCIENCE

In this research, the critical thermal maximum (CTmax) and minimum (CTmin) of Atlantic bluefin tuna larvae were tested. First, the effect of warming/cooling rate (1.5, 3, 6 and 9 °C h^{-1}) on CTmax and CTmin estimates was tested. The selected rate (3 °C h^{-1}) was then used to estimate CTmax and CTmin in preflexion, flexion and postflexion larvae. A total of 9 CTmax trials and 7 CTmin trials were conducted. Trials on small, preflexion larvae (3 - 5 mm) were conducted in 250 mL beakers, while those in larger larvae were done in 2 L beakers. These CTmin and CTmax estimates for larval stages were compared to those available for egg and adult life stages, to explore which are the most sensitive stages to extreme temperatures.

RESULTS

- Mean CTmax estimates ranged between 31 and 35 °C, and those of CTmin between 15 and 19 °C. Later larval stages (already into the piscivory stage) seemed to have slightly higher tolerance, but further research is needed to fully quantify these differences.
- Results suggest that 2 L glass beakers (with 2 to 5 larvae depending on size) are the best experimental units to perform CTmin and CTmax trials on delicate Atlantic bluefin tuna larvae.
- Moreover, no significant effects of warming/cooling rate on CTmin and CTmax were observed. Therefore, 3 °C h^{-1} is recommended, as this rate has already been proposed by other studies on fish and invertebrates.
- Previous research on eggs suggests a similar tolerance (20 to 32 °C) to that estimated here in larvae. In contrast, endothermic adults have a much wider thermal tolerance to cold temperatures, up to 4 °C.

END-USERS & POTENTIAL APPLICATIONS

END-USER 1: Atlantic bluefin tuna farmers and managers
APPLICATION: Establish predictability and improve output and cost control during early larval stages of the lifecycle.

END-USER 2: Ecophysiologists & modellers
APPLICATION: Generate new data on thermal limits of sensitive stages (which is currently limited) in fish in general and specifically Atlantic bluefin tuna, which can be used in models to predict the impact of global warming and other climate threats on the aquaculture sector.

STATUS

Technology Readiness Level (TRL) 1 - basic principles observed

- This study also examined the critical thermal limits of seabream, European seabass and Senegalese sole. The results are currently being analysed for these species.

AT A GLANCE

TITLE: Critical thermal limits of bluefin tuna larvae
KNOWLEDGE TYPE: Scientific publication
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STATUS: Publication in progress
TNA FACILITY USED: Instituto Español de Oceanografía - Marine Aquaculture Plant
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