

# THERMAL THRESHOLD OF THE ONSET OF MATURATION IN CLUPEID FISHES USING QUOTIENT ANALYSIS

Athanassios C. Tsikliras

Department of Zoology, School of Biology, Aristotle University of Thessaloniki, UP Box 134, GR 54124, Thessaloniki, Greece - atsik@bio.auth.gr

## Abstract

The quotient rule analysis was applied to assess the preferred ranges of sea surface temperature for sardine (*Sardina pilchardus*) and round sardinella (*Sardinella aurita*) spawning which was associated with temperatures <16 °C for the former and >21.5 °C for the latter.

**Keywords :** Spawning, Fishes, Temperature, Aegean Sea.

## Introduction

The psychrophilous European sardine (*Sardina pilchardus*) and the thermophilous round sardinella (*Sardinella aurita*) are the most important, in terms of biomass landed, clupeid fishes in the Aegean Sea. Despite the close taxonomic relationship, they exhibit different reproductive strategy in the Mediterranean Sea with the European sardine spawning over an extended period during the winter (see [1] and references therein) and round sardinella spawning over a relatively short period during the summer (see [2] and references therein). The aim of the present work is to assess the thermal threshold which determines the onset of gonadal maturation using an empirical method and the two clupeid fishes as case studies.

## Materials and methods

Samples were collected monthly onboard the northern Aegean purse seine commercial fleet for the period September 2000-August 2002. Sea surface temperature was measured using a CTD probe. The annual reproductive allocation index (ARA), which describes the relative size of gonads and is used as an indicator of reproductive activity was calculated monthly based on the gonad and somatic weights [3].

A quotient-rule analysis [4] was applied to assess the preferred ranges of sea surface temperature for sardine and round sardinella spawning. For each species, the ARA value corresponding to each class was expressed as a percentage of the total ARA values added together (% ARA) and was divided by the percentage frequency of occurrence of each class (% SST) giving the quotient values (Q) for each temperature class [4]:  $Q = (\%ARA)/(\%SST)$ . Quotient values >1 indicate preference to a specific range of variable, while those <1 indicate avoidance of the specific class [4]. Quotient curves were generated from smoothed (using a 6-point running mean) quotient values and were plotted against variables.

## Results and discussion

The quotient curve plots for sardine (Figure 1) and round sardinella (Figure 2) showed their preferred ranges of SST. The quotient values >1 that are indicative of the onset of reproductive activity, were associated with temperatures >21.5 °C for round sardinella, and with temperatures <16 °C for sardine. The results coincide with the reported onset of gonad maturation for the two species at the northern Aegean Sea. Round sardinella has been reported to start spawning in May/June at temperatures exceeding 20 °C. Similarly the European sardine spawns between October and March, i.e., the beginning of gonad maturation occurs at around 16-17 °C.

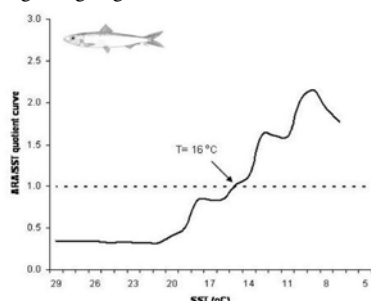


Fig. 1. Quotient curves for European sardine (*Sardina pilchardus*) annual reproductive allocation (ARA) with sea surface temperature (SST, °C). Note the reverse order of x-axis data.

This method is of high importance in fisheries management because it allows a quick pre-estimation of reproductive activity for species whose

spawning is largely depended on environmental and/or climatic factors [2, 5]. However, this method needs to be tested for other species and variables to ensure its efficiency in predicting the onset of spawning based on environmental data.

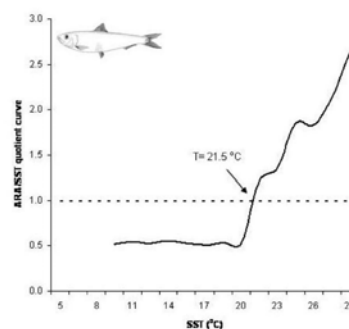


Fig. 2. Quotient curves for round sardinella (*Sardinella aurita*) annual reproductive allocation (ARA) with sea surface temperature (SST, °C).

## References

- 1 - Tsikliras A.C., Antonopoulou E. and Stergiou K.I., 2005. Reproduction of Mediterranean fishes. In: K.I. Stergiou and D.C. Bobori (eds) Fish and more: 3<sup>rd</sup> Mini FishBase Symposium: 37-40. University Studio Press, Thessaloniki, Greece.
- 2 - Tsikliras A.C. and Antonopoulou E., 2006. Reproductive biology of round sardinella (*Sardinella aurita*) in the north-eastern Mediterranean Sea. *Sci. Mar.*, 70: 281-290.
- 3 - Meffe G.K., 1991. Life history changes in eastern Mosquitofish (*Gambusia holbrooki*) induced in thermal elevation. *Can. J. Fisher. Aquat. Sci.*, 48: 60-66.
- 4 - Twatwa N.M., van der Lingen C.D., Drapeau L., Moloney C.L. and Field J.G., 2005. Characterising and comparing the spawning habitats of anchovy *Engraulis encrasicolus* and sardine *Sardinops sagax* in the southern Benguela upwelling ecosystem. *Afr. J. Mar. Sci.*, 27: 487-499.
- 5 - Ettahiri O., Berraho Am., Vidy G., Ramdani M., and Do Chi T., 2003. Observation on the spawning of *Sardina* and *Sardinella* off the south Moroccan Atlantic coast (21-26° N). *Fish. Res.*, 60: 207-222.