EFFECTS OF REDUCED SALINITY CONDITIONS ON ADRIATIC SPRAT (*SPRATTUS SPRATTUS PHALERICUS*) EARLY LIFE STAGE DEVELOPMENTAL SUCCESS

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Abstract

Sprat (*Sprattus sprattus phalericus*) is considered a remnant sub-species of boreal cold biota in the Mediterranean Sea showing a dramatic decrease in stock size since the late 1980´s for reasons poorly understood. For North Adriatic sprat eggs and yolk sac larvae a laboratory study was conducted simulating 8 salinity levels between 5-37.2 psu, to detect potential effects associated with reduced salinity levels as locally predicted to decline in the future. Egg buoyancy, survival, malformation and developmental rates of eggs and yolk sac larvae were assessed. In conclusion, a general high plasticity in development and survival has been observed. A small decrease in surface salinity during sprat spawning season might impact egg and larval survival, although the effect may be countered if positive egg buoyancy is maintained.

Keywords: Global change, Fishes, Larvae, Salinity, Mediterranean Sea

Introduction: European sprat (*Sprattus sprattus*) are small pelagic fish with high ecological and economic importance and North-eastern Atlantic distribution. An isolated sub-species of this "cold adapted species" inhabits the North Adriatic Sea, where it supported local commercial fisheries with a mean annual catch of about 3000t during 1979-1988 [1]. In the late 1980's however the species showed a sharp declining trend in reported landings with an estimated stock size of <1000t in the Eastern Adriatic in 2004. Underlying reasons of such decline remain so far elusive. As it is well known that early life stages (ELSs) of fish (eggs and larvae) are strongly influenced by abiotic factors like temperature or salinity, unfavorable conditions may account for a substantial variability in survival and therefore affect recruitment success. Former studies on Adriatic sprat ELS are restricted to egg abundance, distribution or larval otolith analyzes, while experimental studies are hitherto lacking. The Gulf of Trieste in the North Adriatic Sea is characterized by annual mean±SD surface salinities of 35.3±1.1 and 37.2±0.4 at about 10m depth, respectively [2]. However, the seasonal variability can be substantial leading to regional surface salinities of 29 to 37 [2]. Climate change projections forecast salinity conditions down to almost 30 by 2100 [3]. Here we assess the impact of different salinity conditions on the egg and yolk sac larval buoyancy, developmental duration, malformations and survival.

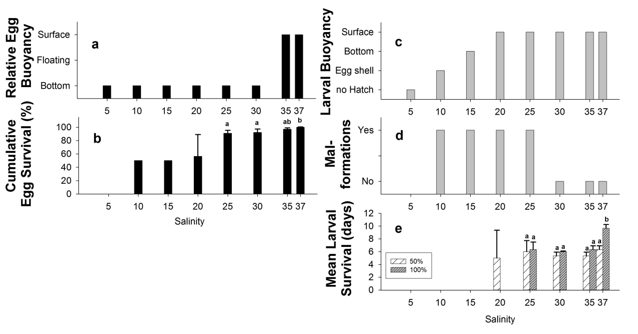

Fig. 1. Relative egg buoyancy (a), cumulative egg survival (b), larval buoyancy (c), occurrence of malformation (d), 50%, 100% mean larval survival duration (e)

Material & Methods: Sprat in spawning condition were caught at night by purse seine fishing in January 2007 in the Gulf of Trieste, Northern Adriatic Sea. They were artificially fertilized (in 37 psu water) onboard and incubated at 11.3 °C in the NIB Marine Biological Station in Piran. Eggs from three females were checked for regular cleavage patterns and pooled at egg development stage IB (12 hours post fertilization) prior to transfer into 250 ml glass beakers filled with 0.2 µm filtered artificial seawater of 5, 10, 15, 20, 25, 30, 35 and 37.2 psu in triplicates. All observations, handlings, removal of dead eggs and larvae as well as water exchange (ca. 50%/day) were made daily (every 24 hours). Egg development duration was followed until >50% of larvae had hatched. The vertical location of eggs and the position of hatched yolk sac larvae were recorded categorically (bottom, floating, surface), termed "relative egg buoyancy" for the egg and "larval buoyancy" for the larval stage. Cumulative egg survival was defined as the number of eggs surviving from loading the beakers until hatch. Categorical occurrence ("yes/no") of malformations for each salinity treatment was recorded.

Results and Conclusion: Positive egg buoyancy is important for marine fish eggs in the sea to survive and disperse, while negative buoyancy may enhance egg mortality due to e.g. hypoxia. Measured positive neutral egg buoyancy at salinities of 35 and 37.2 (Fig 1a) mirrored the salinity range measured in the field during sprat spawning seasons in the Northern Adriatic Sea [2]. However, eggs were negatively buoyant between 30 and 35 psu – reflecting the forecasted salinity range for parts of the Northern Adriatic coastal area by 2100 [3] - which could be increasingly problematic for sprat reproduction in the future. Egg development time in salinities from 10 to 37.2 psu was 4 days, which revealed that time-to-hatch was not influenced by different salinity levels, as shown for other fish species, including Baltic Sea sprat. Successful egg development required salinities exceeding 5 psu (Fig 1b). Cumulative egg survival was significantly different (ANOVA, $p<0.045$) between salinities from 25 to 37.2. Highest mean survival was observed at 37.2 (100%), while it was significantly reduced at 25 and 30 psu (90 and 92% survival) (Fig 1b). Although embryos developed into viable larvae at salinities >10 – 25, a significant contribution of these larvae to recruitment is unlikely, since a large proportion already failed in emerging from the egg shell or showed deformations which handicapped swimming performances (Fig 1 d). These handicaps impact in two ways since the larvae have to accomplish compensation of negative buoyancy (Fig 1 c), hence have to invest more energy to prevent sinking and to balance osmotic differences. The sum of these additional physiological expenses is potentially expressed in the longer survival time of larvae raised at the highest salinity, where those costs are absent (Fig 1 e). We conclude that salinity influences egg buoyancy and survival, but not the egg development duration. In addition, a decrease in surface salinity during spawning season might impact egg and larval survival; although the effect is considered to be of minor importance as long as positive egg buoyancy remains.

References

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