

## Salinity tolerance and correlated physiology of the invasive round goby *Neogobius melanostomus*

Jane W. Behrens\*, Mikael van Deurs\* & Emil A. F. Christensen\*

\*Technical University of Denmark, National Institute of Aquatic Resources, Jægersborg Allé 1, DK-2920 Charlottenlund, Denmark

### Summary

The invasive round goby, *Neogobius melanostomus*, has spread rapidly in the western Baltic Sea during the last two decades, but no oceanic populations have been discovered to date. To evaluate the potential further spread in the western Baltic Sea, the present study determines the effect of salinity on osmoregulation capability (blood plasma osmolality) and aerobic scope (AS; maximum oxygen consumption – minimum oxygen consumption) of the round goby at salinities ranging from 0 to 30. AS was highest and plasma osmolality was stable at salinities between 0 and 20. At higher salinities, AS decreased and plasma osmolality as well as mortality increased. While high salinity had a negative impact on the physiological performance of round goby, the salinity gradient in the Baltic Sea-North Sea transition zone will likely not be a barrier for further dispersal for the species.

### Introduction

The invasive Ponto-Caspian round goby, *Neogobius melanostomus*, has spread rapidly in the Baltic Sea, since its introduction in 1990 (Kornis *et al.* 2012). The species causes a variety of detrimental effects on ecosystems outside its native range, and is currently expanding at a rate of around 30 km per year in the Western region (Azour *et al.* 2015). No oceanic populations have been discovered which may be due to a lack of tolerance of high salinities, or that the invasion front has yet to reach oceanic environments. In order to assess the dispersal potential of round goby in the Baltic Sea-North Sea transition zone, comprising a salinity gradient from brackish to a full marine environment, the present study determined the effects of salinity on aerobic scope and osmoregulation capability. It was hypothesized that round goby would have its highest physiological performance at near isotonic salinities (10-15 PSU), and that the performance would decrease at salinities departing from these values.

### Materials and methods

Round gobies were caught in a Western Baltic brackish water estuary (54°42'N, 11°51'E), and experiments carried out at Den Blå Planet National Aquarium Denmark. Following long-term acclimation to salinities of 0, 10, 15, 20, 25 and 30, standard metabolic rate (SMR) and maximum metabolic rate (MMR) was determined on adult fish (n=8 per group) with intermittent flow resting respirometry (Svendsen *et al.* 2015) to obtain aerobic scope (AS; MMR minus SMR). Blood plasma osmolality was measured on adult fish (n=9-10 in each group), and mortality was noted throughout the 3 months experimental period.

### Results and discussion

Round gobies were able to maintain stable blood plasma osmolality at salinities between 0 and 25 ( $p > 0.05$ ), whereas at 30 PSU, it was significantly lower than at 0-20 PSU ( $p < 0.05$ ; Figure 1). AS was highest at 10 PSU, decreased with increasing salinity, and was significantly lower at 30 PSU compared to 10 PSU ( $p < 0.05$ ; Figure 2). Survival decreased with salinity (Table 1), and there was a strong correlation between the osmotic potential (blood plasma osmolality – ambient osmolality) and AS (two tailed Spearman's rank correlation,  $r_s = -1$ ,  $n = 6$ ,  $p < 0.01$ ). The results show that round gobies have optimal physiological performances at salinities between 0 and 20. At higher salinities, some individuals were challenged osmotically, as evident by the high inter-individual variation in plasma osmolality (Figure 1), and presumably, the osmotic stress lead to high mortality within the 25 and 30 PSU groups (Table 1). It is evident that the physiological performance of the round goby is negatively impacted by high salinity water, yet the results also indicates that the salinity gradient in the Baltic Sea-North Sea transition zone will likely not act as a barrier for further northward dispersal of the species. However, its competitive potential might be mediated due to a decrease in aerobic performance.

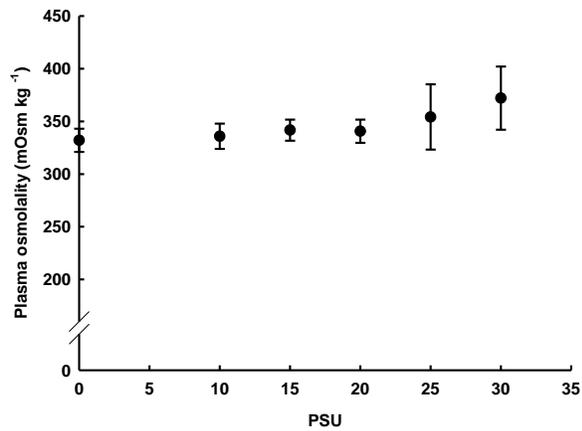


Figure 1. Blood plasma osmolality of round gobies in relation to salinity.

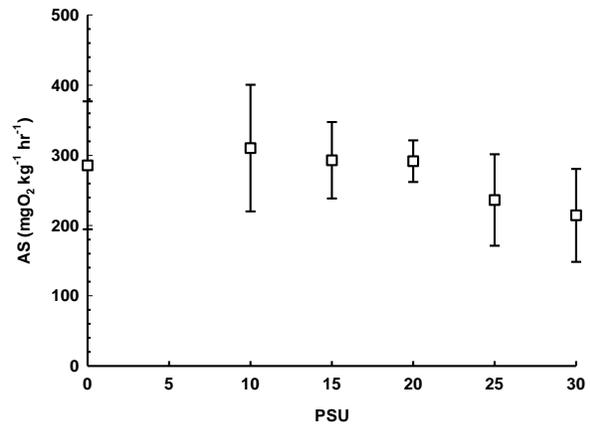


Figure 2. Aerobic scope (AS) of round gobies in relation to salinity.

Table 1. Mortality of round gobies at the different salinities.

0 PSU	10 PSU	15 PSU	20 PSU	25 PSU	30 PSU
NA	1 (5 %)	1 (5 %)	2 (11 %)	5 (28 %)	7 (39 %)

## References

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