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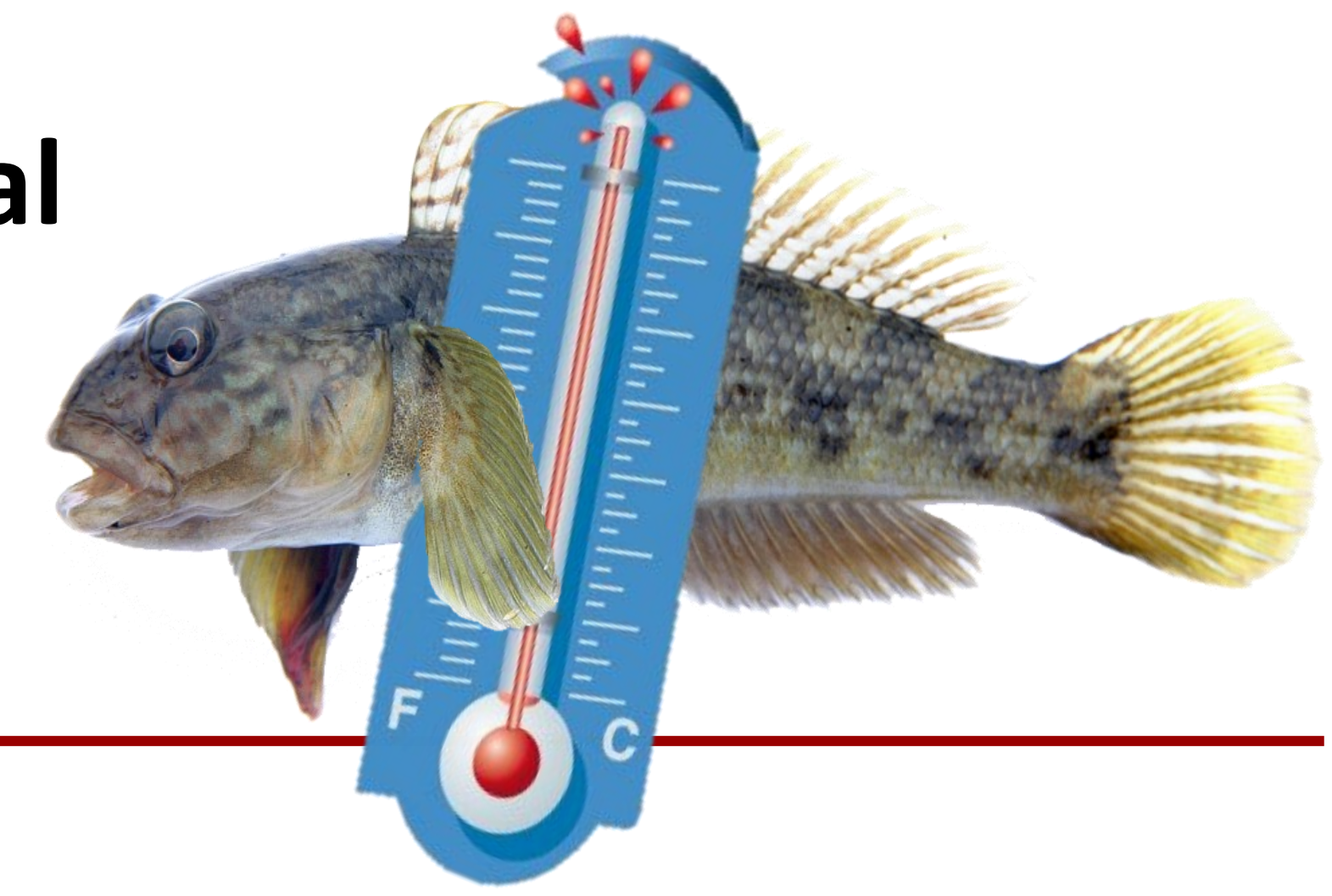
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Invasive fish in a warming world: physiological and behavioural responses of the round goby (*Neogobius melanostomus*)

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Introduction

The invasive potential of introduced species may be enhanced by global warming due to the species' readiness in handling new environments¹. Readiness in handling thermal fluctuation may be characterized with a high level of thermal compensation of metabolic rates, critical thermal maximum (CT_{max}) and behavioral thermoregulation². We investigated this in the widely spread and invasive fish round goby (*Neogobius melanostomus*).

Metabolic rates

We found an unperturbed aerobic scope (maximum metabolic rate [MMR] – standard metabolic rate [SMR]) at 15–28°C, indicating high physiological performance over a broad temperature range (Fig. 1). Furthermore, Q_{10} values of SMR were below 2 between 10 and 25°C, indicating high acclimation capacity in this range. However, Q_{10} values of SMR were >4 below 10 and above 25°C, indicating initiation of rate limiting processes at extreme temperatures.

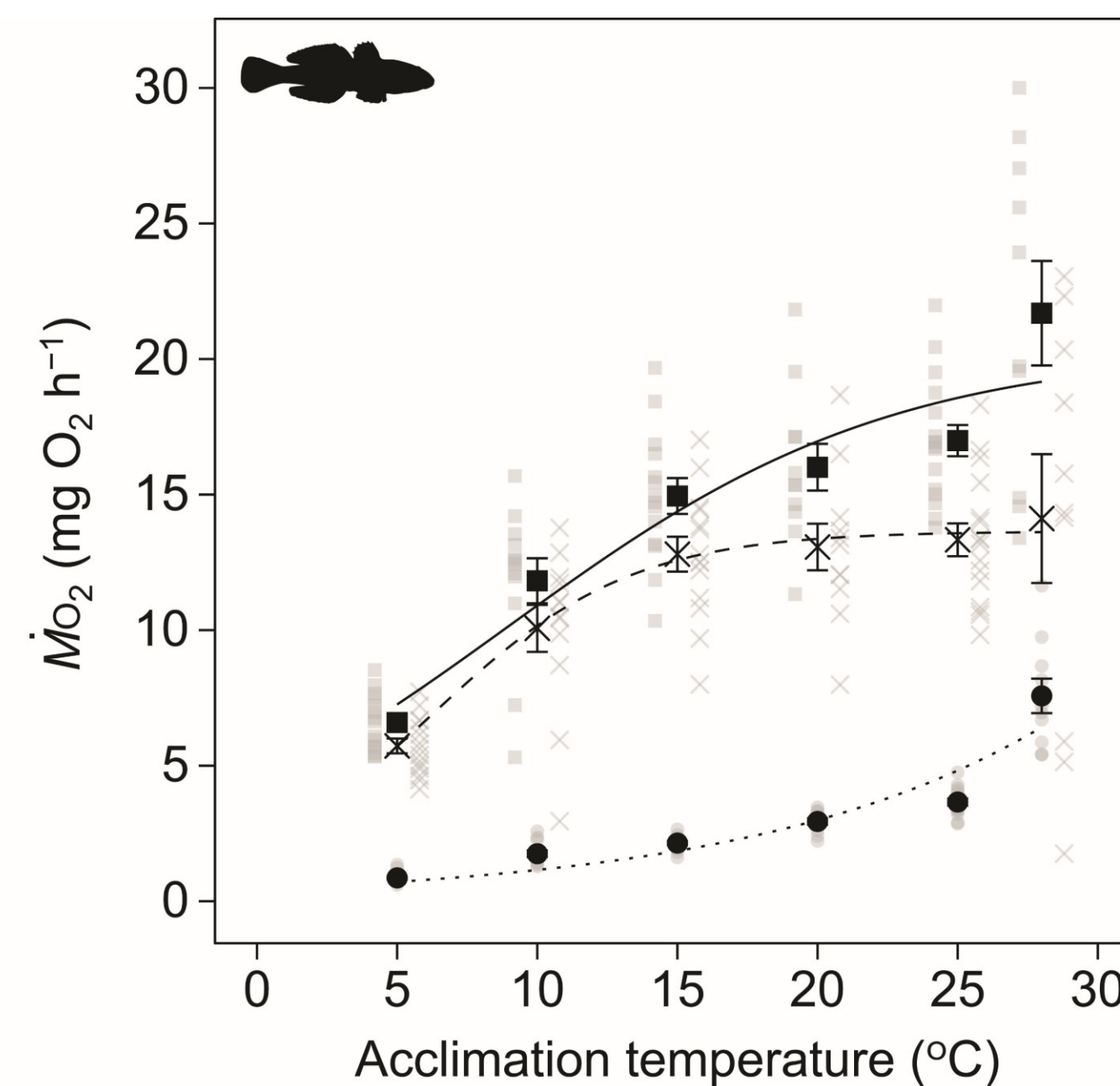


Fig. 1: Effects of temperature on metabolic rates

CT_{max}

The CT_{max} increased with 0.09°C per 1°C in acclimation temperature (Fig. 2), which is relatively little compared to other species³, showing that thermal acclimation of CT_{max} is presumably not a significant trait underlying the species' invasive potential.

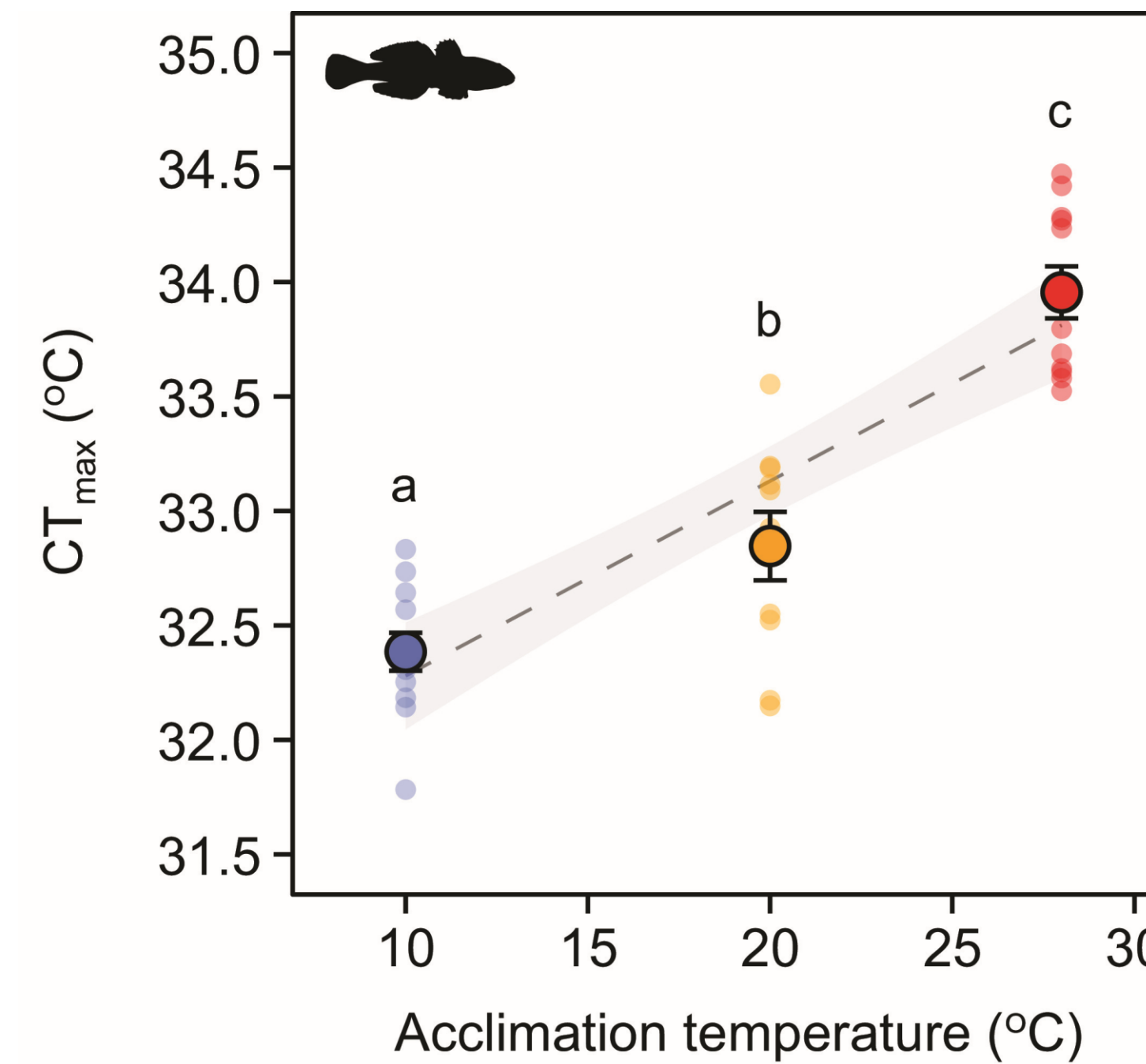


Fig. 2: Effects of temperature on CT_{max}

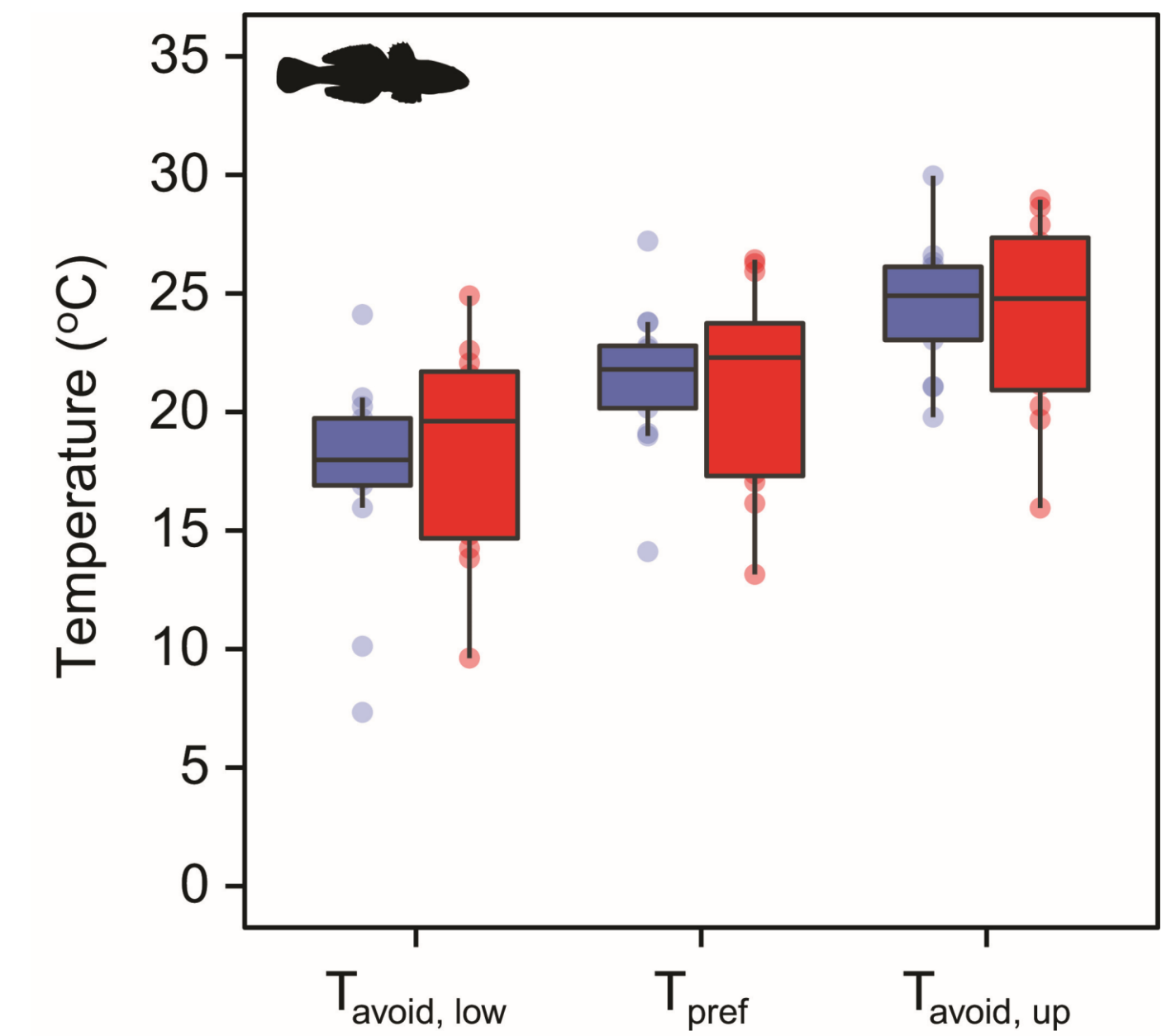


Fig. 3: Effects of acclimation temperature (blue = 10°C; red = 20°C) on behavioral thermoregulation.

Behavioral thermoregulation

There was no effect of acclimation temperature on neither preference nor avoidance temperatures, showing high level of phenotypic buffering for these traits (Fig. 3). The thermal safety margin (CT_{max} – avoidance) temperature was 8.1–8.5°C, and large in comparison with other species⁴.

Conclusions

We conclude that unperturbed aerobic scope and a high level of acclimation capacity of metabolic rate and behavioral thermoregulation over a broad environmental range can make invasive species readily adaptable and ecologically competitive in novel and changing environments.