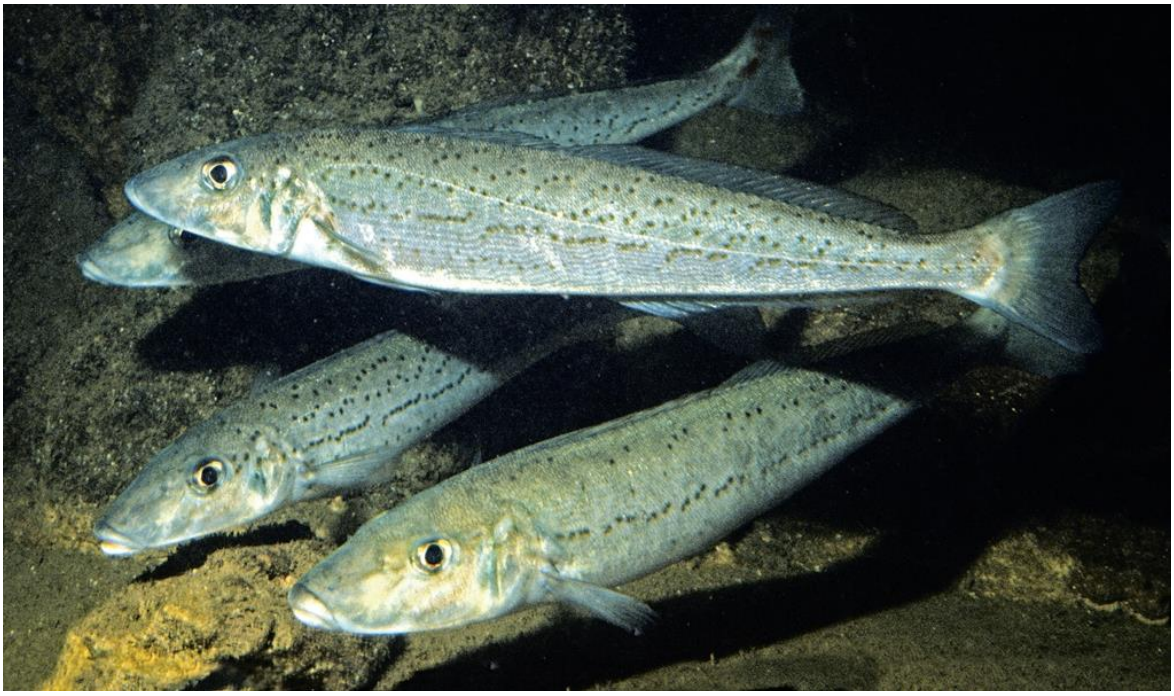
The physiological responses of King George whiting to a changing environment



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Cover image: Adult King George whiting (*Sillaginodes punctatus*)

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Abstract

Environmental variability affects the physiology of marine ectotherms, causing changes to metabolic rate, locomotion and growth. Species that move between habitats with different temperature and salinity for spawning purposes may experience significant changes in their growth rate and physiology compared to those that live in stable environments. Ectotherms have a temperature and salinity range at which growth and survival are optimal. Although, ectotherms are capable of tolerating a range of temperatures and salinities, moving from optimal to extreme ranges can affect oxygen consumption, locomotion and growth. The physiological responses of many marine ectotherms to environmental variability are not well known. King George whiting (*Sillaginodes punctatus*; Sillaginidae) is an important commercial and recreational temperate fish in Southern Australia, with concerns it may be at risk to future climate change. Due to the deficit of information on physiology and growth of this species, they were targeted to evaluate their physiological response to environmental change.

Climate-growth relationships were reconstructed for King George whiting using growth chronologies derived from fish ear bones (otoliths). Otolith samples were collected from Kangaroo Island, Spencer Gulf and Gulf St Vincent in South Australia. A chronological approach was used to examine the inter-annual variation in growth and the influence of region, sea surface temperature (SST), El-Niño Southern Oscillation (ENSO) events (SOI), and recruitment. The growth chronology showed a negative correlation with winter SST. Recruitment and region did not affect growth rate.

The swimming performance and metabolic rate of adult fish was investigated at two temperatures (16°C and 26°C), as well as their potential to recover after a prolonged swimming period, in a resting chamber. Fish were initially swum in a swim chamber, while water velocity

was increased, until exhaustion, then their critical swimming speed (U_{crit}) was calculated. Following exhaustion, fish were transferred into a resting chamber and the maximum metabolic rate (MMR) was calculated. Thereafter, they were allowed to recover in the chamber overnight and their standard metabolic rate (SMR) was measured. The U_{crit} and aerobic metabolic rate were higher at the higher temperature and the fish recovered quicker in warmer water.

A similar study was performed on juvenile fish, but across four temperatures (16, 19, 22 and 25°C) and two salinities (30 and 40ppt), using swim chamber. Metabolic rate of the juveniles was explained by a curvilinear relationship with temperature, but temperature had no influence on U_{crit}. Salinity did not affect the MMR and aerobic scope, but SMR decreased and U_{crit} increased as salinity decreased. The temperature optimum for SMR and aerobic scope was between 16°C and 19°C and their thermal window was between 16°C and 22°C with a critical temperature (T_c) of 25°C.

The effects of temperature and salinity (the same treatments as mentioned above) on otolith elemental composition were investigated as a precursor to tracing environmental history of King George whiting. The concentration of Mg, Mn, Sr and Ba, ratioed to calcium, in juvenile otoliths was influenced by salinity, with a minor effect of temperature and no interaction between temperature and salinity for all element:Ca ratios. This indicated that otolith chemistry maybe useful for reconstructing the salinity history of King George whiting.

I developed methods for evaluating the effects of environmental parameters (e.g. SST, SOI and salinity) on King George whiting growth, physiology and otolith chemistry. Outcomes can be used to assess the growth and metabolic response of King George whiting to temperature and salinity change. The otolith chemistry results can be used for reconstructing the environmental salinity history, and potentially movement patterns, of King George whiting. The temperature examined did not significantly affect the swimming speed and otolith elemental composition of the fish. A plausible reason for these results might be that the temperature range examined was within the species' optimal thermal tolerance window, but any further temperature increase or decrease at both ends of the thermal window can possibly affect the growth and survival of this species.

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