Sublethal effects of diel fluctuations in dissolved oxygen saturation on freshwater fishes from tropical Queensland

Thesis submitted by
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DECLARATION ON ETHICS

The research presented and reported in this thesis was conducted within the guidelines for research ethics outlined in the *National Statement on Ethics Conduct in Research Involving Humans* (1999), *the Joint NHMRC/AVCC Statement and Guidelines on Research Practice* (1997), the *James Cook University Policy on Experimentation Ethics. Standard Practices and Guidelines* (2001), and the *James Cook University Statement and Guidelines on Research Practice* (2001). The proposed research methodology received clearance from the James Cook University Experimentation Ethics review Committee (approval numbers A865 and A624)

Nicole Flint 29-08-05

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ABSTRACT

The effects of diel fluctuations in DO saturation were investigated for four species of tropical freshwater fish at various life history stages. Fluctuating hypoxia was achieved by gradually lowering DO saturation to a minimum level (minimum level differed between treatments), then allowing DO to return to normoxia each day for the duration of experiments. A range of oxygen regimes were tested on juvenile *Lates calcarifer, Melanotaenia splendida splendida* and *Hephaestus fuliginosus*; adult *Melanotaenia utcheensis*; and embryonic *M. s. splendida, M. utcheensis* and *H. fuliginosus*. Immediate lethal limits after gradual oxygen reductions were recorded for each species/life history stage where possible, as well as various effects on the sublethal level, including effects on growth (for juveniles), ventilation (for juveniles), reproduction (for adults) and viability (for embryos).

The four fish species tested were found to be surprisingly tolerant to the oxygen regimes they were exposed to during the study. Species/life history stages that are frequently exposed to hypoxia in natural situations were found to be the most tolerant during experiments. The rank order of resistance of each species/life history stage from highest to lowest was: eggs of *M. s. splendida* and *M. utcheensis* (no immediate lethal level identified), juvenile *L. calcarifer* (immediate lethal level ~2% DO saturation), juvenile *M. s. splendida* and adult *M. utcheensis* (immediate lethal level 6-7%), and juvenile *H. fuliginosus* (immediate lethal level ~7%).

L. calcarifer, *M. s. splendida* and *M. utcheensis* were all capable of aquatic surface respiration at the juvenile and adult stages tested. Juvenile *H. fuliginosus* did not display this adaptive behaviour. Growth and feeding behaviour of juvenile *L. calcarifer* were affected in treatments reaching 5% and 10% minimum DO saturation daily; as was food consumption of some *H. fuliginosus* individuals in the treatment reaching 10% DO saturation daily (5% treatment was lethal for the species).

Eggs of *M. s. splendida* and *M. utcheensis* were completely resistant to the oxygen regimes tested, and more tolerant to hypoxia than juvenile and adult stages of the same species. Reproduction of surviving adult *M. utcheensis* was largely unaffected by exposure to diel fluctuations in DO saturation, although one of two broodgroups

treated with a minimum DO saturation of 10% daily ceased egg production after 18 days of oxygen cycling; and in the same aquarium one of the two female fish was found to have a high percentage of atretic (degenerative) eggs in her ovary.

Although the results suggested that species of fish tested were remarkably tolerant to the sublethal DO regimes imposed during the study, some effects on reproduction, growth and feeding were apparent and may be much more detrimental in natural situations where food must be caught, and mates located. Additionally, longer durations of daily minimum DO saturation, or longer duration of the fluctuating hypoxia regime may increase effects. The results have implications for water quality guidelines for wetlands and waterways of tropical north Queensland, and provide a broad baseline for more targeted research into the effects of hypoxia on fish from the region.

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