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Toolbox

Implantation, orientation and validation of a commercially produced heart-rate logger for use in a perciform teleost fish

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Quantifying how the heart rate of ectothermic organisms responds to environmental conditions (e.g. water temperature) is important information to quantify their sensitivity to environmental change. Heart rate studies have typically been conducted in lab environments where fish are confined. However, commercially available implantable heart rate biologgers provide the opportunity to study free-swimming fish. Our study aimed to determine the applicability of an implantable device, typically used on fusiform-shaped fish (e.g. salmonids), for a perciform fish where morphology and anatomy prevent ventral incisions normally used on fusiform-shaped fish. We found that ventrolateral incisions allowed placement near the heart, but efficacy of the loggers was sensitive to their orientation and the positioning of the electrodes. Electrocardiogram detection, signal strength and subsequent heart rate readings were strongly influenced by logger orientation with a significant effect on the quality and quantity of heart rate recordings. We provide details on the surgical procedures and orientation to guide future heart rate biologger studies on perciform-shaped fish.

Key words: Biologging, electrocardiogram, heart rate, *Pachymetopon grande*, sea bream, Sparidae

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Introduction

Measurement of the heart rate (f_H) of fish can provide estimates of metabolic rate and energy expenditure (Lucas *et al.* 1991; 1993; Cooke *et al.* 2010) and serve as an indicator of stress in response to different environmental conditions and human-induced disturbances (Schreer *et al.* 2001; Graham and Cooke 2008; Brijs *et al.* 2019). As such, quantifying how the f_H of fish responds to environmental stressors like temperature is important to accurately predict how ectothermic organisms will respond to environmental change. Increases in metabolic rates drive a rise in oxygen demand, which relates to an increase in cardiac output (Farrell *et al.* 2009; Ekström *et al.* 2018). This measure of increased cardiac activity, which may relate to food acquisition or predator avoidance, is a promising aspect for the refining of bioenergetics models (Cooke *et al.* 2016). Acquiring remote measurements from wild fish fitted with f_H loggers could provide important

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