In-tank underwater cameras can refine monitoring of laboratory fish

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Abstract

Laboratory animals need to be monitored to check the status of their health and welfare. Routine checks of laboratory fish are limited to visual observations of physical appearance and behaviour, but for species held in opaque-walled tanks, such checks are compromised by restricted views, poor visibility and provoked behaviour. Here, we report our experience of using in-tank underwater cameras to monitor laboratory populations of salmoniforme, perciforme and cypriniforme fish. A range of cameras and lenses were investigated and trialled. A standard VGA resolution analogue camera with a one-third-inch chip and 3.6-mm lens was selected based on size, picture quality, the proportion of tank in view and cost. A shell for the camera and mounting system were designed to minimise size and cleaning and enable flexible positioning within tanks. Cameras were connected via digital encoders to a server, making video available to the general computer network. Data collected from recordings of rainbow trout (Oncorhynchus mykiss) confirmed provoked behaviour, i.e. a change in distribution and increase in activity in response to direct viewing and feeding. The networked cameras therefore enable remote viewing of undisturbed behaviour in real time, providing clear, lateral views unaffected by water surface effects, and facilitate increased frequency of checking. Case studies illustrate how camera monitoring can aid detection of abnormalities in behaviour (e.g. lack of feeding, posture, swimming) and appearance (e.g. clinical signs, such as lesions), enabling earlier interventions. Furthermore, recordings provide a resource for reference and retrospective analysis, and evidence to support severity classification and identify humane end-points.

Keywords: animal welfare, end-point, fish welfare, laboratory fish, refinement, remote monitoring

Introduction

Fishes are cultured in laboratories worldwide and have become a dominant research animal, second only to small rodents (European Commission 2013; Readman et al 2013; Home Office 2017). Although statistics on experimental animals are notoriously weak (Taylor et al 2008; Anon 2014a), millions of fishes are used in experiments each year, e.g. 0.4 million in Norway, 0.3 million in the UK, 1.4 million across EU member states, and 1.6 million in Canada (Knudsen et al 2005; European Commission 2013; CCAC 2017; Home Office 2017). Furthermore, such statistics under-represent the meta-population of laboratory fishes as they typically exclude those used in unregulated experiments, for harvest of tissue and as broodstock, as well as those that die and are killed as surplus to requirement or for welfare reasons (Knudsen et al 2005; Taylor et al 2008).

The statistical nomenclature of ‘fish’ encompasses a wide variety of temperate, tropical, seawater and freshwater species (Animals [Scientific Procedures] Inspectorate [ASPI] 2006). Various species of fish are used for different experimental purposes which include use: in husbandry, nutrition, disease and veterinary medicine research supporting the growing aquaculture industry; as a model in physiological and genetic research; in chemical toxicity testing; and in ecological research (Klontz 1995; Johansen et al 2006; Home Office 2017). In Norway, one farmed species, Atlantic salmon (Salmo salar), accounts for 85% of experimental procedures, with the remaining 15% representing use of 17 other fish species (Knudsen et al 2005). In contrast, in the UK, more than 15 species are used in experiments (ASPI 2006), but one model species, zebrafish (Danio rerio), dominates use (66%; Home Office 2017).

Research laboratories are either legally required or ethically obliged to monitor: i) the fish; ii) the systems and environment upon which fish welfare depends; and iii) for the presence of potentially infectious agents. For example, Directive 2010/63/EU (Anon 2010) requires all laboratory animals to be checked at least once daily to identify any emerging health or welfare issues, and experimental animals are monitored for species-specific signs (indicative of distress, pain or suffering) to enable actual severity assessment and humane end-point intervention. Laboratory animal monitoring should comprise