

WG1 Report (Paolo Domenici & Gudrun De Boeck)

The following report summarizes the progress made and the results achieved within WG1. The identification of problems, progress and perspectives within the subject of the Workgroup 1, "Functional mechanisms behind the beneficial effects of swimming" is reported along with the ongoing preparation of a review paper that synthesizes current knowledge on the functional mechanisms responsible for the beneficial effects of swimming-induced exercise in fish. Reporting also includes stakeholder workshops and STSMs activity.

Evaluation of scientific problems:

Evaluation of existing knowledge on the functional mechanisms behind beneficial exercise effects and identification of gaps in our knowledge for targeting future research efforts (WG1); During our annual meetings, gaps in knowledge and potential future avenues were discussed. The following points were highlighted:

- 1) Identification of the best protocol to determine the optimal speed for growth
- 2) Identification of energy-consuming behavioural traits that can be eliminated by stimulating fish to swim against a current.
- 3) Determination of the potential link between early life swimming capacity and swimming-stimulated growth.
- 4) Determination of the potential link between swimming speed and stress reduction.

Discussion of perspectives

A perspective based on the following points has been discussed:

The issue of the physiological mechanisms relating swimming speed and growth can imply two extreme situations (scales)

- a) Small scale highly controlled experiments in which precise speed and growth can be related. This is however far from the scale needed for aquaculture
- b) Intermediate-scale experiments (higher scales) might be more similar to the aquaculture situation, but do not necessarily tell us what is going on at the organismal level
- c) Large scale experiments: A problem is how to keep track of the activity of each fish, to then relate to its growth. Various promising methods are there (tracking, accelerometry etc), but none works easily at the scale that aquaculture requires. Speed range to be used: There is no theoretical reason why 'optimal speed', where cost of transport is minimized, should be used. Potentially, the full range of aerobic swimming could be used. Even anaerobic (i.e. non sustainable) speeds may have to be used in order to train the white muscle which constitute the highest % of fish meat. Intermittent exposure to such speeds may, however, be stressful.

Publication:

A review paper is being drafted, entitled "Applications for sustained aerobic exercise in aquaculture: production, mitigation & selection", based on the following subheadings:

- Introduction (D. McKenzie)
- Growth/productivity (P. Skov& H. Thoraresen)
- Exercise and stress (D. McKenzie)
- Swimming and operational welfare indicators (S. MacKenzie)
- Immunity (S. MacKenzie)
- Maturation/Reproduction (A. Palstra&J. Planas)
- Cognition and neural plasticity (M.-L. Begout)
- Exercise performance as a selection tool (M. Vandeputte)

Stakeholder workshops:

Stakeholders for WG1 are researchers involved in determining how best to use swimming exercise in order to improve the performance and welfare of farmed fishes. A workshop entitled 'Mechanisms underlying beneficial effects of sustained exercise in finfish aquaculture : state of the art and prospects for development' was held at the Marine Station of the University of Montpellier, in Sète (France) on August 27 2015. Objectives were to discuss:

- (1) current knowledge on the functional mechanisms underlying beneficial effects of exercise in aquaculture
- (2) new candidate species for which exercise might prove valuable
- (3) new ideas and applications for exercise performance in the quantification and optimisation of welfare at different life stages

The workshop focused on the three topics of production, mitigation and selection; major species groups where exercise needs to be studied (tilapia, sturgeon), and some novel areas where exercise research might be extended (as a selection tool, to improve cognition, in the context of operational welfare indicators). The workshop developed the structure of the review article that is currently in preparation.

STSMs within WG1:

Carlos Manuel Alexandre - The effects of abrupt temperature variation on the swimming physiology of Atlantic salmon – with Dr Arjan Palstra.

Sonia Rey Planellas - Assessing the influence of individual variation in coping styles on swimming performance in zebrafish (*Danio rerio*) – with Dr Josep Planas.

Marco Graziano - Evaluation of the effects of sustained swimming on male reproductive development and potential application of swimming to control early maturation in male sea bass (*Dicentrarchus labrax*). – with Dr Josep Planas.

Božidar Rašković - Physiology of common carp (*Cyprinus carpio* L.) swimming in low environmental concentration of ammonia. with Dr Gudrun De Boeck.

Pauline Jéhannet - Gaining insights about the initiation of vitellogenesis by comparing the early vitellogenic shortfin eel (*Anguilla australis*) to the previtellogenic European eel (*A. anguilla*) – with Dr Mark Lokman.

Patrícia Gomes Ferreira - Limiting maximum metabolic rate: is osmorepiratory compromise playing a major role? – with Dr. Jon C. Svendsen.

Caroline Navjord- Effect of size on optimal swimming speed and cost of transport in rainbow, and implications for their use as variables in exercise induced growth improvement – Dr Peter Vilhelm Skov

Katja Anttila - The cardiorespiratory ability of Arctic char and brown trout to respond to environmental warming – Dr Torstein Kristensen.

Daan Mes - Using sustained exercise to enhance brain plasticity, cognition and foraging behaviour in Atlantic salmon – with Dr Arjan Palstra.

Inge Van de Knaap - critical swim speed and oxygen consumption of Atlantic cod (*Gadus morhua*) internally tagged with an accelerometer sensor - with Dr. Gudrun de Boeck