

# Swimming Physiology of Fish

Towards Using Exercise to Farm a Fit Fish in Sustainable Aquaculture

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# Preface

Swimming is an essential characteristic of fish behavior that is intimately linked to the fish's ability to develop, survive, grow, and successfully reproduce in the natural environment. In the fascinating case of anadromous or catadromous semelparous fish species (salmon and eel, respectively), swimming is an absolute requirement for migration from the spawning grounds to the feeding habitats as well as for reproductive migration, when swimming is pivotal in the initiation of sexual maturation and successful return to the spawning grounds in order to complete their life cycle. Many other species of fish rely on swimming as well as for the successful completion of one or more stages in their life cycle. Today, wild fish populations are faced with growing environmental challenges in the form of changing water temperatures and quality as well as in the size and accessibility of aquatic environments. These challenges impinge constraints on the physiology of wild fish, including swimming performance, and, consequently, fitness. Farmed fish are obviously exposed to some of the same environmental and man-caused challenges as wild fish. However, due to the fact that current farming conditions do not allow farmed fish to fully display their normal swimming behavior, farmed fish cannot experience the physiological benefits that swimming entitles their wild counterparts.

Over the last few years, important advances in our understanding of a number of crucial aspects related to swimming in fish have taken place, ranging broadly from a better understanding of swimming during migratory behaviors to investigating the molecular response of skeletal muscle, the engine driving swimming in fish, to swimming-induced contractile activity. This knowledge and its application to fisheries science and aquaculture is already proving instrumental to address important issues related to global environmental changes, high fishing pressures, increased aquaculture production, and increased concern on fish well-being. All these issues are important as well for setting directions for policy decisions and future studies in this area. However, since the seminal work of John Videler entitled "Fish Swimming" published in 1993 by Springer, no other attempts have been made to update and synthesize current knowledge on Fish Swimming. Therefore, the Editors of this book realized the need and the potential

multidisciplinary interest for a comprehensive, modern, and integrative perspective on the Swimming Physiology of Fish and set out to fulfill this objective. Inspiration for the present effort originated as a result of the first International Workshop on the Swimming Physiology of Fish (FITFISH; [www.ub.edu/fitfish2010/](http://www.ub.edu/fitfish2010/)) held in Barcelona, Spain on July 2 and 3, 2010 and organized by the Editors of this book. This was the first attempt to bring together a group of scientists working on Fish Swimming from a number of different perspectives and it was immediately followed by a Symposium entitled “Swimming Physiology of Fish” as part of the 9th International Congress on the Biology of Fish, also held in Barcelona on July 5–9, 2010. This book is unique in bringing together a multidisciplinary group of scientists using exercise models to review their work and view on migration of fishes in their natural environment, beneficial effects of exercise, and applications for sustainable aquaculture. Moreover, it establishes zebrafish as a novel exercise model and presents novel technologies for studying fish swimming and aquaculture applications. In addition, this book describes research strongly suggesting that exercise could represent a natural, non-invasive and economical approach to improve growth, flesh quality as well as welfare of aquacultured fish. The scientific content of this book encourages the industry toward using exercise for farming a fit fish in sustainable aquaculture: A fit fish for a healthy consumer.

The editors would like to thank all the invited contributors for the quality of their contributions and, importantly, for their dedication and time invested in this book. All chapters in this book have been peer-reviewed and the editors would like to thank the reviewers for their efforts in providing constructive criticism to the authors. During the preparation of this book, J. V. Planas would like to acknowledge research support from grants from the Ministerio de Ciencia e Innovación, Spain (AGL2010-08754-E, CSD2007-0002 and AGL2009-07006 to J. V. P). A. P. Palstra was supported by a Marie Curie Intra-European Fellowship (REPRO-SWIM) with Grant Agreement number 219971 during his tenure at the Universitat de Barcelona, Spain, and by a Marie Curie Reintegration Grant (SWIMFIT) with Grant Agreement number 303500 from the European Commission. Specific support for making this book possible was provided by the Aqua-Optima project (number BO-12.04-001-028) funded by the Dutch Ministry of Economic Affairs, Agriculture, and Innovation. Finally, the Editors would like to thank Springer for providing the opportunity to publish this book.

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